THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 61 OCTOBER, 1936 No. 2

COMPOSITION OF PHILIPPINE TOBACCO-SEED OIL

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The production of tobacco is one of the largest industries in the Philippines. The value of cigars, cigarettes, and other tobacco products exported in 1935 amounted to 12,003,658 pesos (Table 1). Large stocks were also produced for domestic consumption. Taxes collected from the tobacco industry help to a very considerable extent in financing the Government.

TABLE 1.—*Tobacco exported from the Philippines in 1935.*[a]

Product.	Quantity.	Value.
		Pesos.
Cigars	223,117,286	6,798,760
Leaf tobacco kg	22,412,659	4,614,920
Cigarettes	16,273,383	43,942
Scraps, etc kg	1,482,173	540,247
Smoking tobacco kg	6,994	3,314
All other kinds kg	60,345	2,475
Total		12,003,658

[a] Philip. Statistical Rev. 2 (1936) 246.

Recently we investigated the oil obtained from Philippine tobacco seeds. The results showed that this oil has a composition similar to that of cottonseed oil, and quite likely it could be used for the same purposes for which cottonseed oil is employed.

Tobacco is now grown successfully in many districts in the Philippines, but the finest quality is produced in the Cagayan

Valley in northern Luzon, where the environmental conditions for growing tobacco are excellent. Cagayan River flows through this valley. During the rainy season the river rises, sometimes to a height of 40 feet, and all the lowlands are inundated. This overflow always leaves on the land a deposit of rich river silt, and thus annually renews the fertility of the soil and makes the use of fertilizer unnecessary. The tobacco plant is exceptionally sensitive to the effects of soil and climate. The uniform climate and the annual fertilization of Cagayan Valley give, with proper cultivation, a crop that shows only very slight variations from year to year. This region is certainly one of the richest in the world for growing tobacco.

The modern factories manufacturing cigars and cigarettes in Manila are considered show places for tourists. Manila cigars are noted for their mildness, and they find a ready sale locally and abroad.

A very interesting and instructive account of Philippine tobacco was published in the Philippine Agricultural Review, volume 20 (1927), first quarter. This issue is called the "tobacco number" and contains the following articles:

Notes on the manufacture of tobacco in the Philippines, by Domingo B. Paguirigan.

A study of the cost of production of tobacco in the Cagayan Valley, by Domingo B. Paguirigan and Ulpiano V. Madamba.

Wrapper tobacco production at the Pikit and Sarunayan Tobacco Experiment Stations and its relation to the Philippine tobacco problem, by Mariano E. Gutierrez.

The Bureau of Agriculture's work on tobacco, by Eduardo R. Alvarado.

A guide for visitors to the Ilagan Tobacco Experiment Station of the Bureau of Agriculture.

A guide for visitors to the Tobacco Experiment Station of the Bureau of Agriculture at Sarunayan, Dulauan, Cotabato.

An index to bulletins, circulars, and articles on tobacco published by the Bureau of Agriculture.

A descriptive list, with cultural directions, of tobacco varieties grown and distributed by the Bureau of Agriculture, is given in circular number 186 of the Philippine Bureau of Agriculture.[1]

Some important varieties of Philippine tobacco have been analyzed by Crisostomo,[2] and comparative analyses of American and Philippine cigarettes have been made by Lava and Etorma.[3]

[1] This bureau is now known as the Bureau of Plant Industry.

[2] Philip. Agri. 23 (1934) 516.

[3] Philip. Agri. 17 (1929) 565.

Several reports [4] on the constants of foreign tobacco-seed oil have been published recently.

Roberts and Schuette [5] investigated the constituents of the oil obtained from Wisconsin-grown tobacco seeds. They found that the oil consisted principally of oleic, linolic, stearic, and palmitic glycerides.

EXPERIMENTAL PROCEDURE

The Philippine tobacco seeds used in this investigation were kindly presented to us by the Compañía General de Tabacos de Filipinas, which is one of the largest tobacco companies in the Philippines. The seeds were a mixture of the Vizcaya and Espada varieties and were obtained from plants grown in the district of Cabagan (Isabela Province) in the Cagayan Valley.

As received in the laboratory, the tobacco seeds contained some stems and dust. The seeds were first passed through a coarse sieve to remove the stems and then through a fine sieve to separate out the dust. They were ground to a fine powder which was extracted with ether. The ether extract was filtered to remove the solid material, and the filtrate distilled to eliminate the ether. The tobacco-seed oil was treated successively (warming, shaking, and filtering) with kieselguhr, suchar, and talcum powder. This treatment removed vegetable fibers and colloidal matter and produced a brilliantly clear oil that had a light yellow color with a slightly greenish tinge. The yield of oil was 39.92 per cent, calculated on a moisture-free basis. The physical and chemical constants are given in Table 2.

TABLE 2.—*Physical and chemical constants of tobacco-seed oil.*

Specific gravity at $\frac{30°}{4°}$ C.	0.9130
Refractive index at 30° C.	1.4714
Iodine number (Hanus)	135.8
Saponification value	190.5
Unsaponifiable matter (per cent)	1.41
Acid value	16.8
Saturated acids, determined (per cent)	10.43
Unsaturated acids, plus unsaponifiable matter, determined (per cent)	83.84
Saturated acids, corrected (per cent)	9.99
Unsaturated acids, corrected (per cent)	82.87
Iodine number of unsaturated acids	153.6

[4] Kruglyakov, I., Tabachnaya Prom. (1934) No. 5, 24. Belyaev, N., Masloboino-Zhirovoe Delo (1932) No. 3, 47. Varga, I., and Géza Dedinszky, Kisérletugyi Koslemények 37 (1934) 153.

[5] Journ. Am. Chem. Soc. 56 (1934) 207.

The saturated and unsaturated acids that occur as glycerides in tobacco-seed oil were separated by the lead-salt-ether method [6] in accordance with the suggestions of Baughman and Jamieson.[7] The results are recorded in Table 3.

TABLE 3.—*Separation of saturated acids from the unsaturated acids of tobacco-seed oil by the lead-salt-ether method.*

Experiment No.	Oil used.	Unsaturated acids.	Saturated acids.	Unsaturated acids (determined).	Saturated acids (determined).	Unsaturated acids [a] (corrected).	Saturated acids (corrected).
	g.	*g.*	*g.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	10.2852	8.6283	1.0681	83.89	[b] 10.38	82.94	9.92
2	20.1192	16.8572	2.1073	83.79	[c] 10.47	82.80	10.05
Mean				83.84	10.43	82.87	9.99

[a] Unsaturated acids (unsaponifiable matter removed); iodine number (Hanus) 153.6.
[b] Iodine number (Hanus), 6.8.
[c] Iodine number (Hanus), 6.2.

The unsaturated acids separated from tobacco-seed oil by the lead-salt-ether method were treated with bromine and converted into their bromoderivatives.[8] No ether-insoluble hexabromide was obtained, thus showing the absence of linolenic acid.

The composition of the mixed unsaturated acids that occur as glycerides in tobacco-seed oil was calculated from the iodine number of the unsaturated acids. The results are given in Table 4. There are also included the calculated percentages of glycerides in the original oil corresponding to these individual unsaturated acids.

TABLE 4.—*Percentage composition of the unsaturated acids of tobacco-seed oil and the glycerides corresponding to these acids.*

Acid.	Mixture of unsaturated acids.	Original oil.	Glycerides in original oil.
	Per cent.	*Per cent.*	*Per cent.*
Linolic	69.55	57.64	60.23
Oleic	30.45	25.23	26.37
Total	100.00	82.87	86.60

[6] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 556.

[7] Cotton Oil Press 6 (1922) 41. Journ. Am. Chem. Soc. 42 (1920) 2398.

[8] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 585.

Saturated acids.—The saturated acids were separated from tobacco-seed oil by the lead-salt-ether method and esterified with methyl alcohol. The mixed acids were dissolved in methyl alcohol and saturated with dry hydrogen chloride gas. The mixture was then heated on a water bath (reflux) for fifteen hours, after which it was treated with water and the ester layer separated. The esters were dissolved in ether and the ethereal solution was washed with sodium carbonate solution and afterwards with water. The ethereal solution was then dehydrated with anhydrous sodium sulphate, filtered, and the ether removed by distilling. The impure esters (87.7062 grams), which were yellow, were distilled under diminished pressure. A preliminary distillation was first made at about 7 millimeters pressure. The esters were redistilled at 5 millimeters pressure. Data on the distillation of the esters are given in Tables 5 and 6.

TABLE 5.—*First distillation of the methyl esters of the saturated acids. (Pressure, 7 millimeters; 87.7062 grams of esters distilled.)*

Fraction.	Temperature.	Weight.
	°C.	g.
A	179–182	31.6445
B	182–187	17.9953
C	187–192	11.3749
D	192–197	12.8286
E	197–200	6.4961
Residue		7.1499
Total		87.4893

TABLE 6.—*Second distillation of the methyl esters of the saturated acids. (Pressure, 5.0 millimeters; 87.4893 grams of esters redistilled.)*

Fraction.		Temperature.	Weight.
From first distillation.	Second distillation.		
		°C.	g.
A and B	1	173–177	23.6154
C	2	177–180	18.7578
D	3	180–187	18.0404
E and residue	4	187–193	9.8511
	5	193–197	8.3775
	6	197–218	7.6228
	Residue		1.1226
Total			87.3876

The analyses of fractions obtained in the second distillation of the methyl esters are given in Table 7. From these data

there were calculated the amounts of the individual acids corresponding to the methyl esters contained in the various fractions. The results are recorded in Table 8.

TABLE 7.—*Analyses of fractions obtained in the second distillation of the mixed methyl esters.*[a]

Fraction.	Iodine number.	Saponification value.	Mean molecular weight of mixed esters.	Composition of mixed esters.		Mean molecular weight of saturated esters.
				Saturated.	Unsaturated.	
				Per cent.	*Per cent.*	
1	2.2	207.6	270.2	98.50	1.50	269.8
2	3.3	205.8	272.6	97.74	2.26	272.1
3	6.7	200.9	279.2	95.42	4.58	278.6
4	10.1	194.7	288.1	93.10	6.90	287.7
5	11.1	189.8	295.6	92.41	7.59	295.6
6	11.9	184.5	304.1	91.87	8.13	304.9

[a] Calculated iodine number of unsaturated methyl esters, 146.3; calculated saponification value of unsaturated methyl esters, 190.4.

TABLE 8.—*Saturated acids corresponding to methyl esters in each fraction.*

Fraction.	Acid.							
	Myristic.		Palmitic.		Stearic.		Arachidic.	
	Per cent.	*g.*	*Per cent.*	*g.*	*Per cent.*	*g.*	*Per cent.*	*g.*
1	1.65	0.3897	91.74	21.6648				
2			86.72	16.2668	5.99	1.1136		
3			63.66	11.4845	26.95	4.8619		
4			33.42	3.2922	55.14	5.4319		
5			8.45	0.7079	79.58	6.6668		
6					66.93	5.1019	20.72	1.5794
Residue[a]								1.0744
Total		0.3897		53.4162		23.1761		2.6538

[a] Residue assumed to be methyl arachidate.

TABLE 9.—*Saturated acids.*

Acid.	Mixture of saturated acids.[a]			Glycerides in original oil.
	Weight.	Composition.	Proportions in original oil.	
	g.	*Per cent.*	*Per cent.*	*Per cent.*
Myristic	0.3897	0.49	.05	.05
Palmitic	53.4162	67.08	6.70	7.03
Stearic	23.1761	29.10	2.91	3.04
Arachidic	2.6538	3.33	0.33	0.34
Total	79.6358	100.00	9.99	10.46

[a] When separated from tobacco-seed oil, the corrected percentage of saturated acids was 9.99.

TABLE 10.—*Comparison of Philippine tobacco-seed oil with other Philippine vegetable oils.*

Constituent.	Tobacco-seed oil.	Kapok-seed oil. [a]	Peanut oil. [b]	Cotton-seed oil. [c]
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Glycerides of—				
Unsaturated acids:				
Oleic	26.37	49.8	53.9	35.2
Linolic	60.23	29.3	27.0	41.7
Saturated acids:				
Myristic	0.05	0.5	----------	0.8
Palmitic	7.03	15.9	8.5	20.0
Stearic	3.04	2.3	3.6	2.0
Arachidic	0.34	0.8	3.4	0.6
Lignoceric	----------	----------	2.4	----------
Unsaponifiable matter	1.41	0.8	0.3	----------
Total	98.47	99.4	99.1	99.8

[a] Philippine kapok-seed oil (Ceiba pentandra), Cruz, A. O., and A. P. West, Philip. Journ. Sci. 46 (1931) 131.

[b] Philippine peanut oil (Valencia variety), Cruz, A. O., and A. P. West, Philip. Journ. Sci. 46 (1931) 199.

[c] American cottonseed oil, Jamieson, G. S., and W. F. Baughman, Journ. Am. Chem. Soc. 42 (1920) 1197.

In Table 9 are given the composition of the mixed saturated acids and the glycerides in the original sample of tobacco-seed oil corresponding to these acids.

The composition of Philippine tobacco-seed oil is recorded in Table 10, in which the analyses of other Philippine vegetable oils are also included for comparison. As shown by the data (Table 10) Philippine tobacco-seed oil is similar in composition to kapok, cottonseed, and peanut oils. All of these oils consist principally of glycerides of oleic, linolic, and palmitic acids. They are suitable commercially for the various purposes for which cottonseed oil is employed; that is, the high-grade oils are useful for making edible products, while the lower grades may be employed for manufacturing soap and similar commodities.

The yield of seeds from Philippine tobacco plants is comparatively small, and the oil obtained from the seeds does not contain constituents of very exceptional value. Considering these facts it would appear that the production of Philippine tobacco-seed oil as an industry is not promising.

SUMMARY

The production of tobacco is one of the leading industries in the Philippines.

The Cagayan Valley in northern Luzon is one of the best districts in the world for cultivating tobacco.

Tobacco seeds were obtained from plants grown in the Cagayan Valley. The oil extracted from these seeds had a composition similar to that of kapok, peanut, and cottonseed oils. All of these oils consist principally of glycerides of linolic, oleic, and palmitic acids, though in different proportions. Quite likely Philippine tobacco-seed oil could be used for the same purposes for which cotton-seed oil is employed.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXXIII[1]

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TWO PLATES

The majority of the species discussed in the present report are from the Khasi Hills, Assam, where they were collected at Cherrapunji by Mr. S. Sircar. A few additional species are from southern Sumatra where they were secured by Mrs. M. E. Walsh. I am greatly indebted to Mrs. Walsh and Mr. Sircar for their appreciated interest in saving these usually neglected flies. The types of the novelties discussed herewith are preserved in my collection of the Tipulidæ.

TIPULINÆ

TIPULINI

TIPULA (SCHUMMELIA) MEDICA sp. nov. Plate 1, fig. 1.

General coloration brown, the præscutum obscure brownish yellow, with four darker brown stripes; antennæ bicolorous; pleura uniformly dark brown; legs black, the femoral bases yellow; wings with a weak brown tinge, with veins Cu and m-cu conspicuously seamed with dark brown; Rs short and straight, shorter than R_{2+3}; cell 1st M_2 diamond-shaped, pointed at both ends; cell M_1 rather short-petiolate; abdomen brownish black, the tergites only restrictedly brightened on their sublateral portions.

Female.—Length, about 14 millimeters; wing, 11.

Frontal prolongation of head brownish black; nasus distinct; palpi black. Antennæ with the scape obscure yellow; pedicel pale yellow; flagellum bicolorous, yellow, the basal enlargement of the segments dark brown; basal enlargements only weakly developed; verticils subequal in length to the segments; terminal segment reduced to a tiny conical structure. Head light brown, the posterior orbits narrowly more grayish; a capillary,

[1] Contribution from the entomological laboratory, Massachusetts State College.

median, dark brown vitta extends from the summit of the entire vertical tubercle backward to the occiput.

Pronotum dark brown. Mesonotal præscutum obscure brownish yellow, with four darker brown stripes, the intermediate pair separated by a vague paler median line; scutal lobes extensively darkened; scutellum testaceous brown, darker brown on either side of the midline, this color including most of the parascutella; mediotergite yellowish brown, darker laterally, the entire surface with coarse, erect black setæ. Pleura almost uniformly dark brown. Halteres with extreme base of stem pale, the remainder broken. Legs with the coxæ infuscated; trochanters yellow; remainder of legs black, the femoral bases yellow, narrowest on the fore and middle legs, much more extensive on the posterior pair. Wings (Plate 1, fig. 1) with a weak brownish tinge; prearcular field more yellowish, cells C and Sc pale brown; stigma dark brown, preceded and followed by restricted cream-colored areas; narrow but complete dark brown seams on m-cu and the entire length of vein Cu; anterior cord and outer veins very narrowly and insensibly seamed with brown; outer radial field weakly darkened, especially in cell R_3; wing apex, as far caudad as vein Cu, together with the axilla, very narrowly darkened; veins brown; obliterative areas of moderate size. Venation: Sc_2 ending just beyond origin of Rs, the latter short and straight, much shorter than R_{2+3}; veins R_{1+2} diverging strongly from R_3, cell R_2 very wide at margin; cell 1st M_2 strongly pointed at both ends, nearly diamond-shaped by the shortening of m; cell M_1 more than three times the length of its petiole; m-cu a short distance before the fork of M.

Abdomen brownish black, variegated by obscure yellow, the tergites restrictedly so on the sublateral portions; sternites more extensively pale. Cerci long and slender.

Habitat.—Assam (Khasi Hills).

Holotype, female, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*).

Generally similar to *Tipula* (*Schummelia*) *klossi* Edwards (Malay Peninsula), differing most evidently in the details of coloration of the body and wings, the shorter trichia of the wing veins, and in the venation, as the even more basal position of m-cu. *Tipula* (*S.*) *pendleburyi* Edwards and *T.* (*S.*) *vitalisi* Edwards are likewise related to the present fly though more distantly so.

TIPULA (SCHUMMELIA) PERGRATA sp. nov. Plate 1, fig. 2; Plate 2, fig. 25.

Belongs to the *continuata* group; antennal flagellum black, only the basal segments feebly bicolorous; præscutum with three brown stripes that are confluent in front; scutum and scutellum with a median dark vitta; pleura yellow; femora obscure brownish yellow, the tips rather narrowly blackened; wings with a faint brownish tinge, restrictedly patterned with brown and variegated by more whitish areas; Rs a little longer than R_{2+3}; m-cu shortly before the fork of M_{3+4}; male hypopygium with the inner dististyle abruptly narrowed into a small blackened apical beak, subtended beneath by an acute blackened spine; notch of ninth sternite with a depressed subcircular lobule.

Male.—Length, about 10.5 millimeters; wing, 12; antenna, about 3.5.

Frontal prolongation of head, together with the conspicuous nasus, yellow, the sides of the prolongation brownish black; palpi black. Antennæ with the scape and pedicel yellow; first flagellar segment yellow basally, darkened at outer end; succeeding two or three segments darker basally than at outer ends, the outer segments uniformly blackened; verticils a little shorter than the segments; terminal segment about one-third as long as the penultimate. Front and anterior vertex yellow, the posterior portions of vertex a little more infumed; a narrow, darker brown median line on posterior vertex, extended caudad from a small median tubercle.

Pronotum brown on median portion, yellow on sides. Mesonotal præscutum with three brown stripes that are confluent in front though narrowly separated behind, leaving linear posterior interspaces of the ground color; præscutal stripes with the central portions a little paler than the borders; humeral and lateral portions of præscutum broadly yellow; scutum broadly yellow medially, the outer portions of lobes dark brown, this being a direct continuation of the lateral præscutal stripe, the median scutal area further divided by a capillary dark central vitta; scutellum yellow, with a median brown line; parascutella dark; mediotergite pale on central portion, the sides darkened. Pleura almost uniformly yellow, scarcely or not at all variegated by darker. Halteres darkened, the extreme base of stem and apex of knob a little brightened. Legs with the coxæ and trochanters yellow; femora obscure brownish yellow, the tips rather narrowly blackened, the amount subequal on all legs; tibiæ and

tarsi black. Wings (Plate 1, fig. 2) with a faint brownish tinge, the prearcular field and cells C and Sc more yellowish brown; stigma dark brown; brown seams along veins Cu and m-cu, interrupted at near three-fourths the length of vein Cu_1 by a large pale area in cell M; anterior cord and outer end of cell 1st M_2 narrowly seamed with brown; veins beyond cord very narrowly bordered by darker; outer ends of anal cells a little darker colored than the ground; cell 1st A with a whitish marginal spot adjoining veins 1st A and 2d A; veins dark, paler in the costal region. Venation: Rs a little longer than R_{2+3}; petiole of cell M_1 a little exceeding m; m-cu long, shortly before the fork of M_{3+4}.

Abdominal tergites obscure yellow, narrowly darkened sublaterally; sternites more uniformly yellow; hypopygium infuscated. Male hypopygium (Plate 2, fig. 25) with the caudal border of the ninth tergite, 9*t*, deeply and broadly emarginate, the dorsal surface rather strongly and convexly arched; border of emargination heavily blackened, without evident median tooth. Outer dististyle, *od*, long and slender, gradually narrowed outwardly, with very long outspreading setæ. Inner dististyle, *id*, with a small blackened beak, the apical point unusually slender, with an acute blackened point directed towards it. Ninth sternite, 9*s*, bearing at base of its median notch a small, depressed, semicircular or oval lobule, densely set with microscopic setulæ.

Habitat.—Assam (Khasi Hills).

Holotype, male, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*).

The closest described allies of the present fly are *Tipula* (*Schummelia*) *continuata* Brunetti and *T.* (*S.*) *xanthopleura* Edwards, of northern India, which differ in the structure of the male hypopygium and in the venational details, as the long, more arcuated R_{2+3} and differently shaped medial cells in *continuata*, and the longer Rs, which considerably exceeds R_{2+3}, in *xanthopleura*. Edwards has given descriptions of the hypopygial distinctions of the two species mentioned.[2]

TIPULA (VESTIPLEX) TUTA sp. nov. Plate 1, fig. 3.

Mesonotum yellow, the præscutum with four more olive-brown stripes that are very vaguely bordered by slightly darker brown; scutellum and postnotum with a narrow, darkened, median vitta; pleura obscure yellow; tips of femora narrowly blackened; wings

[2] Ann. & Mag. Nat. Hist. X 1 (1928) 698–699.

strongly suffused with brownish yellow, almost unpatterned; Rs long, subequal to vein R_3; petiole of cell M_1 very short; abdominal tergites yellow, narrowly trivittate with dark brown; sternites yellow, with a median brown line; cerci slender, each with about a dozen strong teeth.

Female.—Length, about 17 millimeters; wing, 14.2.

Frontal prolongation of head obscure yellow, narrowly lined with darker on sides; nasus stout; palpi black. Antennæ with the scape and pedicel obscure yellow, flagellum brown, the basal enlargements of the segments not or scarcely darkened; longest verticils a little shorter than the segments. Head obscure orange or orange-yellow, with a vague, median, darker line on vertex.

Mesonotal præscutum yellow, with four more olive-brown stripes that are vaguely bordered by slightly darker brown; anterior ends of intermediate stripes barely confluent; scutum obscure yellow, the lobes variegated by more olive-brown; scutellum olive-brown, narrowly darker medially; postnotum more golden-yellow pollinose, with a narrow dark median vitta that is narrowed behind and does not reach the posterior margin. Pleura obscure yellow, the anepisternum a little variegated by darker. Halteres brownish yellow, the knobs dark brown. Legs with the coxæ and trochanters obscure yellow; femora brownish yellow, the tips narrowly but conspicuously blackened, the amount subequal on all legs and involving about the distal seventh or eighth of the segment; tibiæ and basitarsi obscure yellow, the tips narrowly darkened; remainder of tarsi darkened. Wings (Plate 1, fig. 3) strongly suffused with brownish yellow, the stigma and a more or less evident cloud on anterior cord a little darker than the ground; no distinct dark pattern on wing, as is the case in all other species of the subgenus; obliterative areas across cell 1st M_2 conspicuous; veins brown. Venation: Rs relatively long, subequal to vein R_3; petiole of cell M_1 very short; M_{3+4} subequal to basal section of M_3.

Abdominal tergites yellow, narrowly bordered sublaterally with dark brown, the lateral margins narrowly buffy; a continuous, dark brown, median stripe on tergites; sternites yellow, with a broad, nearly continuous, dark brown, median stripe. Ovipositor with cerci slender, each with about a dozen strong teeth along more than the distal half.

Habitat.—Assam (Khasi Hills).

Holotype, female, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*).

The nearest described ally of the present fly is *Tipula* (*Vestiplex*) *nigroapicalis* Brunetti, of the eastern Himalayas, readily distinguished by the different wing pattern and venation. A paratype of the latter species is before me and indicates a very different fly. The practically obsolete wing pattern of the present insect will serve to separate the species from all others so far known.

LIMONIINÆ

LIMONIINI

LIMONIA (GERANOMYIA) MERACULA sp. nov. Plate 1, fig. 4.

General color reddish, the præscutum with three narrow brown stripes; rostrum short, in the female only about one-third the length of the remainder of body, black, with a pale ring just before the very short tips of the labial palpi; legs yellow; wings whitish subhyaline, heavily patterned with brown, including a series of six major costal areas; areas two to four, inclusive, widened posteriorly and there inclosing pale centers; last dark costal area a complete subapical fascia; Sc long, Sc_1 ending just before the fork of Rs; abdominal tergites dark brown, the posterior borders of the segments narrowly pale; sternites pale.

Female.—Length, excluding rostrum, about 6 millimeters; wing, 6.5; rostrum, about 2.

Rostrum relatively short, in female only about one-third the remainder of body, black, narrowly paler just before the very short, divergent tips of the labial palpi. Antennæ short, black throughout; flagellar segments short-oval, with verticils that are subequal in length to the segments. Anterior vertex and front obscure silvery, the color continued caudad onto the posterior vertex as a silvery line of slightly greater width; posterior portion of head blackened.

Pronotum reddish brown above, more blackened on sides and as a narrow median line. Mesonotal præscutum reddish, with three very narrow brown stripes, the median one beginning on the pronotum, not attaining the suture behind; lateral stripes subequal in width to the median, reaching or passing the suture but vague and diffuse behind; scutellum, median region of scutum, and the posterior median portion of the præscutum more testaceous; postnotum reddish brown, more darkened on sides. Pleura almost uniformly reddish brown, the dorsal sclerites scarcely darker. Halteres dusky. Legs with the coxæ and trochanters yellowish testaceous; remainder of legs, yellow, only the terminal tarsal segments somewhat darker. Wings (Plate 1, fig. 4) whitish subhyaline, heavily patterned with brown, includ-

ing a series of about six major costal areas, arranged as follows: At arculus; at supernumerary crossvein in cell Sc; origin of Rs; tip of Sc_1; stigma; tip of vein R_{2+3}; of these areas the first is small and ill-defined, spreading distad in cell Sc and thence crossing cells R and M just beyond arculus; areas two to four widen out behind in cell R and here have the centers pale, the lateral darkenings appearing as pincer-shaped areas in cell R; stigmal area large and extensive, involving cell R_3; terminal area a complete subapical crossband extending from cell R_2 to cell M_4, sending a dark spur to wing apex along vein R_{4+5}; in addition to the six major areas, there are small paler areas in cells C and Sc only, lying between the major areas one and two, two and three, and three and four, respectively; narrow, solidly darkened seams along cord and outer end of cell 1st M_2; small brown spots at ends of veins Cu_1, 1st A, and 2d A, the last largest; a small darkened marginal spot at near midlength of cell 2d A; veins dark brown. Venation: Sc long, with Sc_1 ending nearly opposite the fork of Rs, Sc_2 at its tip; free tip of Sc_2 and R_2 both pale and in transverse alignment; m-cu close to fork of M; vein 2d A bent rather strongly to wing margin, the cell widest just before outer end.

Abdominal tergites dark brown, the posterior borders of the segments narrowly pale; sternites obscure yellow; genital shield chiefly pale; bases of hypovalvæ blackened.

Habitat.—Assam (Khasi Hills).

Holotype, female, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*).

Limonia (*Geranomyia*) *meracula* is quite distinct from the other described regional species of the subgenus, especially in the wing pattern which is very different from that of the other Indian and Malayan species. The most similar forms are *L.* (*G.*) *avocetta* (Alexander) and *L.* (*G.*) *semistriata* (Brunetti), but the resemblance is not particularly close.

LIMONIA (GERANOMYIA) FUMIMARGINATA sp. nov. Plate 2, fig. 26.

Allied to *pictorum;* size large (wing, male, 7 millimeters); general coloration of præscutum reddish brown, with three narrow darker brown stripes; pleura yellowish, the dorsal portion a little more darkened; knobs of halteres infuscated; legs yellow; wings pale yellow, with a heavy dark pattern, including six major costal areas that are pale brown, narrowly bordered by darker brown; posterior cells of wing with numerous small brown dots; Sc_1 ending opposite or shortly beyond midlength of

Rs; male hypopygium with the median notch of the tergite shallow; ventral dististyle large; rostral spines two, arising from a common tubercle.

Male.—Length, excluding rostrum, about 7 millimeters; wing, 7; rostrum, about 3.

Rostrum relatively long, nearly one-half the length of the remainder of body, black throughout; free tips of labial palpi slender. Antennæ black throughout; flagellar segments oval, with inconspicuous verticils. Head with the narrow anterior vertex gray, the color produced caudad onto the posterior vertex almost to occiput; remainder of vertex black.

Pronotum pale yellow, narrowly darkened medially above and on sides. Mesonotal præscutum reddish brown, the humeral and lateral portions paling to light yellow; disk of præscutum with three narrow darker brown stripes, the median one wider in front, narrowed behind and reaching the suture; lateral stripes subequal in width to the interspaces; scutal lobes reddish brown, their mesal portions variegated with darker brown; scutellum chiefly pale, with a narrow, darker, median vitta, the parascutella darker; mediotergite dark brown. Pleura yellowish, the dorsal portion a little more darkened, the color a little more expanded on the pleurotergite. Halteres pale, the knobs infuscated. Legs with the coxæ and trochanters tinged with green; remainder of legs yellow, the terminal tarsal segments darkened. Wings with a pale yellow tinge, the prearcular and costal regions a very little more saturated yellow; a heavy brown pattern, chiefly costal in distribution, including six major areas, arranged as follows: First at arculus; second at the supernumerary crossvein in cell Sc; third and fourth at origin of Rs and fork of Sc, respectively, in cases united with one another along Rs; fifth area stigmal; sixth at outer end of R_{2+3}; a smaller marking at outer end of cell R_3; major costal areas with their central portions paler brown than the narrow dark margins; cord and outer end of cell 1st M_2 narrowly seamed with brown; small scattered brown dots in most of the cells of the wing, including R, M, Cu, 1st A, 2d A, and, usually, in some of the cells beyond the cord; veins pale, darker in the infuscated areas. Venation: Sc_1 ending opposite or shortly beyond midlength of Rs, Sc_2 at its tip; m-cu at fork of M.

Abdominal tergites brown; sternites light yellow; hypopygium a little brightened. Male hypopygium (Plate 2, fig. 26) much as in *pictorum*. Ninth tergite, 9*t*, with the median notch shallow. Ventral dististyle, *vd*, larger, the rostral prolongation

small but stout; rostral spines two, slightly unequal in size, arising from a common tubercle. Dorsal dististyle at apex produced into a long, slender, darkened spine.

Habitat.—Assam (Khasi Hills).

Holotype, male, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*). Paratopotype, male.

The most similar described species is *Limonia* (*Geranomyia*) *pictorum* Alexander,[3] which differs conspicuously in the smaller size and very different wing pattern, the dark costal areas being solidly infuscated, not pale in the centers with narrow darker borders, as is the case in the present species. Correlated with the above are minor differences in venation and in the structure of the male hypopygium.

LIMONIA (GERANOMYIA) OFFIRMATA sp. nov. Plate 1, fig. 5.

General coloration reddish yellow, the præscutal disk chiefly covered by three dull black, confluent stripes; femora yellow; wings grayish yellow, with a very restricted, darker brown pattern, including small spots at the supernumerary crossvein in cell Sc, origin of Rs and tip of Sc; stigma darkened; Sc_1 ending opposite two-thirds the length of Rs.

Female.—Length, excluding rostrum, about 5.5 millimeters; wing, 6.4; rostrum, about 1.7.

Rostrum unusually short, less than a third the length of the remainder of body, black throughout; divergent tips of labial palpi very short. Antennæ with the scape dark brown, the remainder of organ black; flagellar segments oval, with short inconspicuous verticils. Anterior vertex silvery, the posterior portion of head darkened.

Pronotum pale brown above, more blackened laterally. Mesonotal præscutum reddish yellow on sides and humeral portion, the disk chiefly covered by three, dull black, confluent stripes; scutal lobes dull black, the median area somewhat paler, traversed by a narrow, more blackened, median vitta; scutellum pale brown; postnotum dull black. Pleura almost uniformly yellow. Halteres with the stem yellow, the knob infuscated. Legs with the coxæ, trochanters, and femora yellow; tibiæ and tarsi darker brown, the terminal tarsal segments even darker. Wings (Plate 1, fig. 5) with an almost uniform grayish yellow suffusion, very restrictedly patterned with darker, distributed as fol-

[3] *Limonia* (*Geranomyia*) *pictorum* Alexander, Philip. Journ. Sci. 40 (1929) 247; new name for *L.* (*G.*) *pulchripennis* (Brunetti), Fauna Brit. India, Dipt. Nematocera (1912) 393; preoccupied.

lows: Three very small spots, at the supernumerary crossvein in cell Sc, origin of Rs and tip of Sc, respectively; stigmal area larger, oval; cord and outer end of cell 1st M_2 not, or at most only narrowly, seamed with darker; veins yellow, darker in the infuscated portions. Venation: Sc of moderate length, Sc_1 ending about opposite two-thirds the length of Rs, Sc_2 at its tip; supernumerary crossvein in cell Sc at near midlength of the distance between arculus and origin of Rs; free tip of Sc_2 lying a little proximad of R_2, the latter curved gently into vein R_1 to form a composite arcuated vein; m-cu close to fork of M.

Abdominal tergites dark brown, the caudal borders scarcely paler; sternites obscure yellow, with broad paler posterior margins. Ovipositor with the genital shield pale; cerci and hypovalvæ short and slender, horn-colored.

Habitat.—Assam (Khasi Hills).

Holotype, female, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*).

The most similar described species in the Oriental fauna are *Limonia* (*Geranomyia*) *atrostriata* (Edwards), of Formosa, and *L.* (*G.*) *notatipennis* (Brunetti), of the Abor district of northern Assam, both of which have the dark pattern of the wings restricted in a manner somewhat similar to that in the present fly. The latter species differs evidently in the coloration of the thoracic dorsum, the legs, and the wings.

ANTOCHA (ANTOCHA) PLUMBEA sp. nov. Plate 1, fig. 6.

Belongs to the *vitripennis* group; general coloration gray, the præscutal stripes poorly indicated; posterior portions of mediotergite and the ventral sternopleurite more blackened; antennæ black throughout, the terminal segment elongate; halteres pale yellow; legs black, the femoral bases restrictedly obscure yellow; wings whitish, the prearcular region more milky white; stigma oval, pale brown; veins brown, conspicuous against the ground; Rs unusually long; R_2 lying a short distance beyond level of r-m; m-cu about one-third its length before the fork of M; abdomen brownish black.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum light brown; palpi black. Antennæ short, black throughout; basal flagellar segments subglobular to short-oval; intermediate segments oval; outer segments more elongate, the terminal one longest, about one-half longer than the penultimate; verticils exceeding the segments in length, except on the outer ones. Head dark gray.

Mesonotum gray, the præscutum with the usual stripes only a trifle darker and more infuscated than the ground color; scutal lobes darkened; mediotergite more blackened on posterior half. Pleura black, the surface strongly pruinose, the ventral sternopleurite more polished black; dorsopleural region darkened. Halteres pale yellow throughout. Legs with the coxæ black, pruinose; trochanters testaceous-yellow; remainder of legs black, only the femoral bases narrowly obscure yellow, the amount subequal on all legs. Wings (Plate 1, fig. 6) whitish, the prearcular region clearer milky white; cells C and Sc a trifle more yellow; stigma oval, pale brown; veins brown, distinct against the ground, pale in the prearcular and costal areas. Vein R_3 with trichia only on about the distal fourth. Venation: Rs unusually long, approximately twice R alone; R_2 relatively short and pale, traversing the outer end of stigma, subequal in length to R_{1+2} and lying distinctly beyond the level of r-m; cell 1st M_2 small; m-cu about one-third its length before the fork of M.

Abdomen brownish black; valves of ovipositor brownish horn-color.

Habitat.—Sumatra (south).

Holotype, female, Tandjong Sakti, Benkoelen, altitude 1,650 to 2,000 feet, June 1 to 10, 1935 (*Walsh*).

Antocha (*Antocha*) *plumbea* is most generally similar to *A.* (*A.*) *javanensis* Alexander, of western Java, differing especially in the dark plumbeous-gray coloration, black antennæ and legs, and the slightly longer Rs.

ANTOCHA (ANTOCHA) BASIVENA sp. nov. Plate 1, fig. 7; Plate 2, fig. 27.

Belongs to the *nigribasis* group; general coloration pale yellow, the thorax unmarked; vertex darkened medially; legs pale brown; wings tinged with pale cream-color; stigma brown; R_{2+3} short; cell 1st M_2 small, shorter than any of the veins issuing from it; m-cu far before the fork of M; male hypopygium with the inner gonapophysis appearing as very flattened, long-oval spatulas; outer apophysis a pale sinuous rod, its distal end slightly expanded, the tip acute.

Male.—Length, about 2.6 to 3 millimeters; wing, 3 to 3.5.

Rostrum obscure yellow; palpi brown. Antennæ brown throughout; flagellar segment oval, with short verticils. Head yellow, the vertex darkened medially.

Entire thorax very pale yellow, unmarked. Halteres pale yellow. Legs with the coxæ and trochanters yellow; remainder of legs uniformly pale brown, the terminal tarsal segments scarcely

darkened. Wings (Plate 1, fig. 7) tinged with pale cream-color, the radial field more whitened; stigma oval, brown, relatively conspicuous against the ground; veins pale brown. Venation: Sc ending at near three-fourths the length of the long Rs; R_2 subequal to R_{1+2} and a little shorter than R_{2+3}; cell 1st M_2 small, shorter than any of the veins issuing from it; m-cu unusually far basad, more than its own length before the fork of M.

Abdomen uniformly yellow. Male hypopygium (Plate 2, fig. 27) with the outer dististyle, *od*, a gently curved pale blade, the apex narrowly rounded. Inner dististyle, *id*, pale, a little longer than the outer, with conspicuous pale setæ on outer half. Inner gonapophysis, *ig*, a very broadly flattened, long-oval spatula; outer apophysis, *og*, a slender, sinuous, pale rod, a little widened towards outer end, the long-produced apex acute.

Habitat.—Assam (Khasi Hills).

Holotype, male, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*). Paratopotype, male.

Antocha (*Antocha*) *basivena* is readily told from the other Indian species of the *nigribasis* group by the small size, unmarked wings, venation, and structure of the gonapophyses of the male hypopygium.

All of the species of *Antocha* described from British India (Himalayan Region) by Brunetti belong to the *vitripennis* group, having vein R_2 in approximate transverse alignment with r-m and with m-cu close to the fork of M. These species include *Antocha* (*Antocha*) *indica* Brunetti, *A.* (*A.*) *triangularis* (Brunetti), and *A.* (*A.*) *unilineata* Brunetti. Four additional members of the genus recently taken in the Khasi Hills, Assam, by Mr. Sircar belong to the *nigribasis* group, distinguished by having vein R_2 lying somewhat proximad of the level of r-m, so that vein R_{2+3} is short to very short, and with m-cu placed at a considerable distance before the fork of M. Except for the closed cell 1st M_2, the venation of the various members of this group is almost exactly like that of members of the subgenus *Orimargula* Mik.

The four species mentioned may be distinguished by means of the accompanying key.

1. Femora pale yellow, the tips narrowly and abruptly blackened; wings with a restricted dark pattern, in addition to the stigmal darkening, best evidenced by narrow seams along the cord..... 2.
   Femora uniformly pale brown or with the tips only insensibly darkened; wings unmarked except for the small stigmal area..... 3.

2. Prearcular field of wing and cell Sc to opposite the origin of Rs blackened ..... *A.* (*A.*) *khasiensis* Alexander.
   Prearcular field of wing and cell Sc entirely clear. *A.* (*A.*) *sparsipunctata* sp. nov.
3. Thorax entirely pale yellow, immaculate; cell 1st M_2 small, shorter than any of the veins issuing from it..... *A.* (*A.*) *basivena* sp. nov.
   Thorax yellow, the præscutum with a brown median stripe; cell 1st M_2 larger, subequal in length to vein M_4 beyond it. *A.* (*A.*) *scelesta* sp. nov.

ANTOCHA (ANTOCHA) SCELESTA sp. nov. Plate 1, fig. 8; Plate 2, fig. 28.

Belongs to the *nigribasis* group; general coloration obscure brownish yellow, the præscutum with a conspicuous, dark brown, median stripe; pleura with ventral anepisternum and ventral sternopleurite weakly darkened; wings milky white, unmarked except for the small, irregular, pale brown stigma; m-cu approximately its own length before the fork of M; male hypopygium with the outer dististyle at apex produced into a spikelike point; outer gonapophysis slender, nearly parallel-sided on distal portion, the tip acute.

Male.—Length, about 3.5 millimeters; wing, 3.8.

Female.—Length, about 4.5 millimeters; wing, 4.

Rostrum obscure yellow; palpi dark brown. Antennæ short; scape obscure yellow; flagellum brownish black; flagellar segments oval. Head reddish brown, the front, anterior vertex, and posterior orbits more buffy.

Pronotum dark brown medially, paling to yellow on the sides. Mesonotum obscure brownish yellow, the præscutum with a conspicuous, dark brown, median stripe, widest in front, suddenly narrowed behind, becoming obsolete before the suture; no trace of lateral stripes; mediotergite a little darkened, especially behind. Pleura obscure yellow, the ventral anepisternum and ventral sternopleurite slightly darkened. Halteres pale yellow throughout. Legs with the coxæ and trochanters yellow; femora obscure yellow, the tips narrowly and very insensibly darkened; tibiæ a little darker than the yellow tarsi. Wings (Plate 1, fig. 8) with the ground color milky white, the prearcular and costal portions a trifle more cream-colored; veins pale brown, even lighter colored in the creamy areas; stigma small and irregular in outline, pale brown. Venation: R_{2+3} short, as in the group, only about one-third of the basal section of R_{4+5}; cell 1st M_2 of moderate size, about as long as vein M_4 beyond it; m-cu approximately its own length before the fork of M.

Abdomen pale brown, the sternites and hypopygium a trifle more yellow. Male hypopygium (Plate 2, fig. 28) with the outer dististyle, *od*, rather strongly curved, at apex produced into a long, spikelike point. Outer gonapophysis, *og*, slender, very gently curved, beyond the slightly dilated basal portion nearly parallel-sided for its entire length, the tip narrowed to an acute point.

Habitat.—Assam (Khasi Hills).

Holotype, male, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*). Allotopotype, female.

The closest ally is *Antocha* (*Antocha*) *basivena* sp. nov., which differs especially in the uniformly pale yellow coloration, the details of venation, and the structure of the male hypopygium, notably of the outer dististyle and gonapophyses. The other related regional species may best be separated by the key given under the account of the preceding species.

ANTOCHA (ANTOCHA) SPARSIPUNCTATA sp. nov. Plate 1, fig. 9.

Belongs to the *nigribasis* group; general coloration pale yellow, including the entire thorax and abdomen; tips of femora and tibiæ narrowly darkened; wings pale yellow, the prearcular, costal, and subcostal areas pale; a restricted dark pattern at origin of Rs, stigma, cord, and outer end of cell 1st M_2; R_{2+3} short, m-cu more than its length before the fork of M; male hypopygium with the outer dististyle slender, the tip subacute.

Male.—Length, about 4 millimeters; wing, 4.5.

Rostrum yellow; palpi dark brown. Antennæ brown throughout; flagellar segments oval. Head darkened above.

Entire thorax pale yellow, unmarked. Halteres pale yellow. Legs yellow, femoral tips narrowly dark brown, the amount of color subequal on all legs; tibiæ yellow, tips more narrowly darkened; tarsi yellow, the outer segments infuscated. Wings (Plate 1, fig. 9) almost uniformly suffused with pale yellow, the prearcular and costal portions a very little more brightened; a restricted dark pattern, distributed as follows: Origin of Rs; cord and outer end of cell 1st M_2; veins pale, darkened in the infuscated portions; veins beyond cord somewhat darker in color than most of the more basal veins. Venation: R_2 lying far before level of r-m; R_{2+3} shortened; m-cu more than its own length before the fork of M.

Abdomen, including hypopygium, entirely pale yellow. Male hypopygium much as in *khasiensis*, the outer dististyle somewhat more slender, with the apex subacute.

Habitat.—Assam (Khasi Hills).

Holotype, male, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*). Paratopotype, male.

Antocha (*Antocha*) *sparsipunctata* finds its closest relative in *A.* (*A.*) *khasiensis* Alexander, which differs in the darkened wing base and cell Sc, slightly different body coloration, and the short and broad outer dististyle of the male hypopygium, with the apex obtusely rounded.

ANTOCHA (ORIMARGULA) PRÆSCUTALIS sp. nov. Plate 1, fig. 10.

General coloration of thorax reddish brown, the præscutum dark brown on median portion in front; lateral margin of præscutum behind the humeral region with a large velvety-black spot; thoracic pleura pruinose, with very large velvety-black areas covering most of the anepisternum and pleurotergite; halteres yellow; legs with the femora brown, the tibiæ light brown with the tips narrowly darkened; wings pale gray, the prearcular area paler; stigma darker; veins brown; abdomen brown, the bases of the individual sternite paler.

Male.—Length, about 4.5 to 5 millimeters; wing, 5 to 5.3.

Female.—Length, about 5 millimeters; wing, 6 to 6.2.

Rostrum brown; palpi black. Antennæ black, the basal segment more pruinose; flagellar segments oval, with a dense white pubescence and short verticils; terminal segment a trifle longer than the penultimate. Front and anterior vertex light gray pruinose; remainder of head dark gray.

Cervical sclerites dark brown, paler laterally. Pronotum yellow. Mesonotal præscutum reddish brown, broadly darker brown on median portion in front, this color paling to the ground color before midlength of the sclerite; lateral border of præscutum behind the humeral region with a large velvety-black spot; scutum and scutellum grayish brown, the latter brightened on caudal portion; mediotergite chiefly dark brown. Pleura reddish, heavily pruinose, with two large velvety-black areas, one occupying most of the anepisternum, the other most of the pleurotergite. Halteres pale yellow throughout. Legs with the coxæ brownish yellow; trochanters yellow; femora brown; tibiæ light brown, the tips narrowly darker brown, the amount subequal on all legs; tarsi brownish yellow to pale brown. Wings (Plate 1, fig. 10) with a pale grayish tinge, the prearcular area paler; stigma long-oval, pale brown; veins brown, the anterior branch of Rs and R_2 paler. Venation: Rs a little longer than R alone, gently convex; R_2 a little shorter than the slightly

more arcuated R_{2+3}; petiole of cell M_3 about one-half m-cu, the latter a little more than its own length before the fork of M.

Abdomen brown, the bases of the sternites a little more yellowish brown; hypopygium light yellow.

Habitat.—Sumatra (south).

Holotype, male, Moeara Tenam, Benkoelen, June 16 to 23, 1935 (*Walsh*). Allotopotype, female, with the type. Paratopotypes, 2 males, July 4 to 14, 1935. Paratypes, 2 females, Tandjong Sakti, Benkoelen, altitude 1,650 to 2,000 feet, June 1 to 10, 1935 (*Walsh*).

Antocha (*Orimargula*) *præscutalis* is most nearly allied to *A.* (*O.*) *maculipleura* Edwards, of Mount Kinabalu, northern Borneo, which has similar velvety-black spots on the thoracic pleura. The present fly is distinguished by its smaller size and the presence of a third conspicuous velvety-black area on the lateral margin of the præscutum.

HELIUS (HELIUS) LECTUS sp. nov. Plate 1, fig. 11.

General coloration pale yellow, without conspicuous markings; antennæ brownish black throughout; head gray; legs brownish yellow to pale brown; wings strongly tinged with yellow, the stigma pale, barely indicated; anterior branch of Rs sinuous, bent gently caudad opposite the stigma; cell 1st M_2 elongate, subrectangular, a little longer than vein M_4 beyond it; abdomen yellow, the tergal incisures and pleural membrane a little darkened.

Female.—Length, including rostrum, about 6.5 millimeters; wing, 6.

Rostrum a little longer than the remainder of head, obscure yellow; palpi pale brown. Antennæ brownish black throughout; flagellar segments short-oval, with inconspicuous verticils. Head gray; anterior vertex narrow, subequal to the diameter of the scape.

Cervical sclerites elongate, light brown. Pronotum and mesonotum uniform yellow to testaceous-yellow, without markings. Pleura testaceous-yellow. Halteres pale, the knobs a little darkened. Legs with the coxæ and trochanters testaceous-yellow; remainder of legs long and slender; femora brownish yellow, the tips scarcely darkened; tibiæ pale brown; tarsi obscure yellow. Wings (Plate 1, fig. 11) with a strong yellow tinge, the prearcular and costal portions a little brighter; stigma pale, barely indicated against the ground; veins brownish yellow. Macrotrichia on vein R_{1+2}, R_3, R_5, M_{1+2} and outer portions of M_3. Venation: Sc_2 ending opposite r-m, much longer than Sc_1 which is

very short to virtually lacking; anterior branch of Rs sinuous, bent gently caudad opposite the stigma, the distal end more or less parallel to vein R_{1+2}, cell R_2 narrow at margin; cell 1st M_2 elongate, subrectangular, slightly exceeding vein M_4 beyond it; m-cu nearly one-half its length beyond the fork of M.

Abdomen yellow, the lateral region and incisures of the tergites restrictedly darkened; sternites more uniformly pale yellow. Ovipositor with valves elongate, horn-colored.

Habitat.—Assam (Khasi Hills).

Holotype, female, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*).

The most similar regional species is the much larger *Helius* (*Helius*) *ferruginosus* (Brunetti), which differs in the dark body coloration and in the venation, such as the more elongate Rs and uniformly arched anterior branch of Rs, with cell R_2 at margin less than one-third as extensive as cell R_3. I am basing the above statements on a comparison of the type of *lectus* with metatypical specimens of *ferruginosus*. The latter are from lower altitudes of the Darjiling district, eastern Himalayas, altitude 2,000 to 4,500 feet, and may not be conspecific with the actual type of *ferruginosus*, which was from the Dawna Hills, Lower Burma. I believe the material is correctly named, since the venation agrees closely with that of the type as figured by Bagchi.[4]

HELIUS (HELIUS) SELECTUS sp. nov. Plate 1, fig. 12.

General coloration black, the præscutum with four more reddish brown stripes; rostrum black; antennæ black throughout; halteres and legs black, the femoral bases and outer tarsal segments paler; wings weakly suffused with brown, the stigma and costal border darker; cell 1st M_2 shorter than any of the veins issuing from it; abdominal tergites black, sternites yellow, the subterminal segments obscure.

Female.—Length, including rostrum, about 8 millimeters; wing, 7.5.

Rostrum black, a little longer than the remainder of head. Antennæ black throughout; flagellar segments oval, the outer segments more elongate; verticils subequal in length to the segments. Head black.

Cervical region and pronotum black. Mesonotal præscutum brownish black, with four more reddish brown stripes, the in-

[4] Brunetti, Fauna Brit. India, Diptera Nematocera (1912) pl. 8, fig. 8.

termediate pair only narrowly separated by a capillary dark vitta; scutal lobes dark brown, the median area obscure yellow; scutellum brownish black; mediotergite dark liver brown. Pleura with the dorsal sclerites and the pleural membrane brownish black; the ventral portion, including the outer half of the fore coxæ, ventral sternopleurite, and meron, obscure yellow. Halteres black. Legs obscure yellow, the fore coxæ darkened on proximal half; trochanters obscure yellow; legs black, the femoral bases restrictedly brightened, the outer tarsal segments paling to obscure brownish yellow. Wings (Plate 1, fig. 12) with a weak brown suffusion, the stigma long-oval, darker brown; cell C brownish yellow, cell Sc a little more darkened; veins dark brown. Costal fringe (female) dense but relatively short; virtually complete series of trichia on Rs and branches, and on outer sections of all medial veins. Venation: Sc_1 with distal end atrophied, Sc_2 close to its tip; Rs long and nearly straight; anterior branch of Rs gently but evenly arcuated, narrowing cell R_2 opposite the stigma, the tip of the vein very gently upcurved; cell R_3 at margin a little less than three times cell R_2; cell 1st M_2 relatively small, short-rectangular, its lower face (M_{3+4}) shorter than any of the veins issuing from the cell; m-cu a short distance before the fork of M.

Abdominal tergites black, the sternites yellow, with the subterminal segments more obscure. Genital shield of ovipositor darkened; valves yellowish horn-colored.

Habitat.—Assam (Khasi Hills).

Holotype, female, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935 (*Sircar*).

Allied to *Helius* (*Helius*) *nigriceps* Edwards and related forms, differing in the large size, body coloration, and wing venation.

ORIMARGA (ORIMARGA) DISTIVENULA sp. nov. Plate 1, fig. 13.

General coloration brown, the pleura more brownish yellow; wings relatively broad, faintly tinged with brown, the entire costal border narrowly more yellowish; no macrotrichia on anterior branch of Rs; Sc_1 ending almost opposite fork of Rs; free tip of Sc_2 lying distad of R_2; m-cu just beyond midlength of Rs.

Male.—Length, about 4.5 millimeters; wing, 4.4.

Rostrum brown; palpi black. Antennæ black throughout; flagellar segments oval. Head dark brown, the front and anterior vertex a little brighter; anterior vertex relatively wide.

Pronotum dark brown. Mesonotum uniformly brown, without stripes, the lateral portions of præscutum a little brightened.

Pleura brownish yellow. Halteres white, the knobs infuscated. Legs with the coxæ and trochanters yellow; remainder of legs dark brown, the tarsi a little brightened. Wings (Plate 1, fig. 13) relatively broad, faintly tinged with brown, the entire costal border narrowly more yellowish; veins pale brown, a trifle more yellowish in the costal field. Costal fringe relatively short; no macrotrichia on anterior branch of Rs; a series of about fifteen on distal section of vein R_{4+5}; sparse, scattered trichia on outer ends of veins M_{1+2} and M_3; remaining veins beyond cord without trichia. Venation: Sc long, Sc_1 ending almost opposite the fork of Rs, Sc_2 a short distance from its tip; free tip of Sc_2 lying distad of level of R_2; Rs long, nearly twice the basal section of R_{4+5}; R_{2+3} shorter than the basal section of R_{4+5}, subequal to R_{1+2}; m-cu just beyond midlength of Rs; vein 2d A long.

Abdominal tergites dark brown; sternites more testaceous-yellow; hypopygium broken.

Habitat.—Assam (Khasi Hills).

Holotype, male, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935 (*Sircar*).

Orimarga (*Orimarga*) *distivenula* is very distinct from the other species of the genus in eastern Asia, the chief characters being its broad wings with vein Sc of unusual length and the distal position of the free tip of Sc_2. In all other species of the genus the latter element is either atrophied or lies opposite to some distance before the level of R_2. The present instance is of unusual interest in that it parallels the condition found in the allied genus *Limonia*, where numerous species are known that have the free tip of Sc_2 migrated distad beyond the level of R_2.[5]

ORIMARGA (ORIMARGA) SUBBASALIS sp. nov. Plate 1, fig. 14.

Closely allied to *basalis;* general coloration of mesonotum gray pruinose; knobs of halteres weakly darkened; legs brownish black; wings narrow, weakly suffused with gray, the prearcular field restrictedly brightened; numerous macrotrichia on veins beyond cord; Sc long, free tip of Sc_2 faint; R_{2+3} long, exceeding the strongly arcuated Rs.

Female.—Length, about 7 to 7.5 millimeters; wing, 6.

[5] Alexander, C. P., The interpretation of the radial field of the wing in the nematocerous Diptera, with special reference to the Tipulidæ, Proc. Linn. Soc. New South Wales 52 (1927) 42–72, 92 figs.—A comparison of the systems of nomenclature that have been applied to the radial field of the wing in the Diptera, IVth Internat. Cong. Ent., Trans. 2 (1929) 700–707, 3 pls.—In Curran, C. H., The families and genera of North American Diptera (1934) 38–39, figs.

Rostrum obscure yellow; palpi black. Antennæ black throughout; flagellar segments oval, with a short, dense, white pubescence; terminal segment shorter than the penultimate. Head dark gray, more silvery on the front; anterior vertex relatively narrow, slightly blackened.

General coloration of mesonotum gray pruinose, the central portion of præscutum a little darker; median region of scutum slightly paler gray. Pleura brown, the extensive sternopleurite much paler, sparsely pruinose. Halteres white, the knobs weakly darkened. Legs with the coxæ reddish yellow, the fore coxæ slightly darker; trochanters yellowish brown; femora brownish black, the bases narrowly and vaguely brightened; tibiæ and tarsi brownish black. Wings (Plate 1, fig. 14) narrow, weakly suffused with gray, the prearcular field restrictedly whitened; veins pale brown. Macrotrichia abundant on veins beyond cord, there being more than fifty-five on distal section of R_{4+5}, more crowded towards outer end of vein. Venation: Sc long, Sc_1 ending a short distance before fork of Rs, Sc_2 close to its tip; free tip of Sc_2 faint, a distance before R_2 about equal to the length of vein R_{1+2}; R_{2+3} long, exceeding the strongly arcuated Rs; R_{1+2} a little less than one-half R_{2+3}; cell M_3 longer than its petiole; m-cu placed unusually far basad, opposite the origin of Rs or nearly so.

Abdominal tergites dark brown; sternites obscure yellow to reddish yellow. Ovipositor with tergal shield pale; valves darker.

Habitat.—Assam (Khasi Hills).

Holotype, female, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*). Paratopotypes, 2 females.

Orimarga (*Orimarga*) *subbasalis* is most closely allied to *O.* (*O.*) *basalis* Alexander (Kashmir), agreeing closely in the venation and trichiation of the veins, differing most evidently in the darkened knobs of the halteres, brownish black femora, and gray wings with more evidently darkened veins. In *basalis* the halteres are whitish throughout, the femora are pale with a poorly indicated darker subterminal ring, and the wings are pale yellow, with yellow veins.

PEDICIINI

NIPPONOMYIA KHASIANA sp. nov. Plate 1, fig. 15; Plate 2, fig. 29.

General coloration yellow, the præscutum and scutum with a pattern of eight black spots arranged in a circle; femora entirely yellow; tibiæ yellow, the tips narrowly blackened; wings whitish hyaline, with a clear yellow submarginal stripe extending from

the wing base to near apex; costal cell with four brown spots, the outermost at tip of vein Sc_1; no continuous dark seam on cord; cell M_2 open by atrophy of m.

Male.—Length, about 9 millimeters; wing, 8.5.

Female.—Length, about 10 to 11 millimeters; wing, 8.

Rostrum and palpi yellow. Antennæ yellow, only the terminal flagellar segments a very little more infuscated; flagellar segments short and crowded. Head uniformly pale yellow.

Mesonotal præscutum yellow, with three more polished yellow stripes and a transverse series of four circular black spots, the intermediate pair placed just behind midlength of the sclerite, the lateral pair a little nearer the suture, gently curving the row; scutum with lobes deep yellow, variegated on cephalic-lateral portion and again on posterior-median area of each lobe by a circular black spot; the eight marks on the præscutum and scutum thus form a short-oval figure but with no additional darkened sutural area, as in *novempunctata*; posterior sclerites of notum uniformly yellow. Pleura pale yellow throughout. Halteres yellow. Legs yellow, the femora entirely unvariegated; tips of all tibiæ narrowly but conspicuously blackened, the amount subequal on all legs; tarsi yellow, the tips of the individual basal segments narrowly darkened; outer tarsal segments uniformly infuscated. Wings (Plate 1, fig. 15) whitish hyaline, with the usual clear yellow submarginal stripe extending from the wing base to near apex, bordered both above and below by a narrow brown streak; clear portion of costal cell without black dashes but with four brown extensions, the last at tip of Sc_1; extreme wing tip clear; cord virtually undarkened, with a narrow seam on m-cu; vein Cu narrowly bordered with brown on basal portion; veins pale, darker in the clouded areas. Venation: As in the genus; basal section of R_5 very short to virtually lacking; cell M_2 open by atrophy of m; m-cu at or close to fork of M.

Abdomen obscure yellow, the tergites very vaguely darkened at bases. Male hypopygium (Plate 2, fig. 29) with the dististyle, *d*, trispinous. Interbase, *i*, as figured, expanded on basal portion.

Habitat.—Assam (Khasi Hills).

Holotype, male, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*). Allotopotype, female. Paratopotypes, 2 females.

Nipponomyia khasiana is very different from the only species of the genus hitherto discovered in India, *N. novempunctata*

(Senior-White)[6] likewise from the Khasi Hills. By my key to the known species of *Nipponomyia*,[7] the present fly runs to couplet 6, including *trispinosa* (Alexander), of Japan, and *sumatrana* (de Meijere), of Sumatra. It is readily told by the pattern of the thorax, legs, and wings, and by the open cell M_2. The fly is one of the smallest species of the genus so far discovered.

HEXATOMINI

ADELPHOMYIA (ADELPHOMYIA) DISCALIS sp. nov. Plate 1, fig. 16; Plate 2, fig. 30.

General coloration pale yellow; antennæ 16-segmented, the scape and pedicel brownish black, the flagellum obscure yellow; halteres and legs yellow; wings pale yellow, the anterior cord restrictedly darkened, the color including the veins; no trichia in cells of wing; Rs long, arcuated at origin; R_{2+3+4} short; R_{2+3} subequal to R_2; cell M_1 present; male hypopygium with the basistyle produced apically into a subacute spine; outer dististyle trispinous at apex.

Male.—Length, about 4.8 to 5.2 millimeters; wing, 5.5 to 6.

Female.—Length, about 6 millimeters; wing, 6.

Rostrum dark; palpi black. Antennæ 16-segmented; scape and pedicel brownish black, flagellum obscure yellow; flagellar segments gradually becoming more slender and elongate outwardly, the longest verticils of the outer segments subequal in length to the segments themselves. Head obscure yellow; eyes (male) large, restricting the anterior vertex.

Entire thorax uniformly pale yellow. Halteres pale yellow throughout. Legs yellow, the terminal two tarsal segments darker. Wings (Plate 1, fig. 16) uniformly pale yellow, variegated only by a restricted dark cloud on the anterior cord, most evident in the dark brown veins of the area; remaining veins yellow. Wing widest just basad of end of vein 2d A; no macrotrichia in outer cells of wing. Venation: Sc_1 ending nearly opposite fork of Rs, Sc_2 removed a short distance from its tip; Rs long, arcuated at origin; R_{2+3+4} relativey short, nearly twice the length of R_{2+3}, the latter subequal to or longer than R_2; r-m relatively long, arcuated; cell M_1 small, less than one-half its petiole; m-cu at near midlength of lower face of cell 1st M_2; vein 2d A long, ending beyond the level of origin of Rs.

Abdomen, including hypopygium, yellow. Male hypopygium (Plate 2, fig. 30) with the basistyle, *b*, produced caudad beyond

[6] Senior-White, Mem. Dept. Agr. India, Ent. Ser. 8 (1922) 138–139.

[7] Alexander, C. P., Philip. Journ. Sci. 56 (1935) 551–552.

the point of insertion of the dististyles, the apex subspinous, with long coarse setæ almost to the tip. Outer dististyle, *od,* trispinous at apex. Inner dististyle, *id,* broad at base, narrowed to the obtuse tip.

Habitat.—Assam (Khasi Hills).

Holotype, male, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*). Allotopotype, female. Paratopotypes, 3 males.

Adelphomyia (*Adelphomyia*) *discalis* is very distinct from the other known Asiatic species of the genus in the pale yellow wings with a single restricted darkened cloud on disk, and in the lack of macrotrichia in the cells of the wing. All other species of the genus so far made known have at least a few trichia in the outer radial of medial fields. The structure of the male hypopygium of the present fly is entirely as in the genus, and there can be no question as to the systematic position of the species.

ADELPHOMYIA (ADELPHOMYIA) SUBNEBULOSA sp. nov. Plate 1, fig. 17; Plate 2, fig. 31.

Allied to *nebulosa;* general coloration brownish black; antennæ with basal five segments yellow, the remainder black; femora blackened outwardly, with a narrow, pale yellow, subterminal ring; tibiæ dark brown, the extreme base and tip pale; tarsi brownish yellow; wings cream-yellow, with a heavy clouded brown pattern, including three virtually complete crossbands on the basal third; all veins at wing margin with large clouds; R_2 some distance before fork of R_{3+4}; cell M_1 longer than its petiole; anal veins strongly curved to margin; male hypopygium with basistyle terminating in a slender blackened spine.

Male.—Length, about 4.8 millimeters; wing, 5.

Rostrum and palpi black. Antennæ 16-segmented; scape, pedicel, and basal three flagellar segments light yellow, the remainder of flagellum black; flagellar segments becoming long-cylindrical, with long conspicuous verticils that exceed the segments in length. Head brownish black, the anterior vertex paler.

Mesonotum almost uniform brownish black, the surface polished; humeral region of præscutum restrictedly obscure brownish yellow. Pleura brownish black, with a silvery longitudinal stripe across the dorsal sternopleurite and ventral pteropleurite, ending before the halteres. Halteres with base of stem and the knob yellow, the remainder of stem dusky. Legs with the coxæ and trochanters obscure yellow; femora obscure yellow

basally, passing into black at (on forelegs) or beyond (middle and hind legs) midlength, with a narrow, light yellow, subterminal ring placed at about its own length before the black apex; tibiæ dark brown, the base very narrowly, the tip a little more broadly, whitened, the subbasal portion of the segment a little more intensely darkened; tarsi brownish yellow, the terminal two segments darker. Wings (Plate 1, fig. 17) obscure cream-yellow, with a heavy clouded brown pattern, including three narrow, virtually complete crossbands on proximal third, the first arcular, the third extending from costa opposite origin of Rs to end of vein 2d A; on central portion of disk, these bands more diffuse and interconnected in cells M and Cu; other more isolated, dark costal spots at Sc_2, R_2, and tip of R_{1+2}, the latter two inclosing a small pale spot, behind becoming confluent and suffusing the entire cord; other small clouds at outer end of cell 1st M_2 and fork of M_{1+2}; a series of marginal brown clouds at ends of all longitudinal veins, smallest on R_{4+5} and M_1, becoming progressively larger behind, most extensive on the anal veins; proximal third of cell R_4 clouded; veins pale, darkened in the suffused areas. Rather restricted macrotrichia in outer cells of wing, including cell R_2 beyond vein R_2, and in the outer ends of cells R_3 to 2d M_2, inclusive. Wings (male) widest opposite the end of cell 1st A. Venation: Sc_2 removed to some distance from the tip of R_{1+2}; R_2 oblique, some distance from fork of R_{3+4}; tips of veins R_3 and R_4 bent rather strongly cephalad, of the medial, cubital, and anal veins, strongly caudad, especially the last; basal section of M_{1+2} reduced to a point, narrowing the base of cell 1st M_2, r-m correspondingly lengthened; cell M_1 deeper than its petiole; m-cu about one-half its length beyond the fork of M.

Abdomen black; hypopygium a trifle paler, more brownish black. Male hypopygium (Plate 2, fig. 31) with the basistyle, *b*, terminating abruptly in a slender blackened spine. Outer dististyle, *od*, slender, with two outer, terminal, curved spines and an inner straight point.

Habitat.—Assam (Khasi Hills).

Holotype, male, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*). Paratopotypes, males.

The only near ally of the present fly is *Adelphomyia* (*Adelphomyia*) *nebulosa* (de Meijere), of western Java, which has the venation of the radial and medial fields almost the same as in the insect under consideration. This latter species differs most evidently in the details of pattern of the legs and wings.

From de Meijere's figure of the type of *nebulosa*,[8] it appears that in this species the macrotrichia of the cells of the wing are more numerous and that the anal veins are not strongly curved into the wing margin. It is certain that the generic name *Oxydiscus*, proposed by de Meijere for this fly, must fall as a strict synonym of *Adelphomyia*, the male hypopygium being entirely distinctive.

LIMNOPHILA (DICRANOPHRAGMA) MULTIGEMINATA sp. nov. Plate 1, fig. 18; Plate 2, fig. 32.

General coloration of mesonotum reddish brown, the posterior sclerites and the pleura more blackened; antennæ black, the pedicel and first flagellar segment yellow; legs yellow, the femora with a very indistinct darker subterminal ring; wings broad in male, narrower in female, pale yellow, heavily patterned with dark brown, the areas restricted to the vicinity of the veins; markings along cord and at the supernumerary crossvein in cell R_3 more extensive and subtended on either side by smaller dark dots; a series of subterminal brown spots in cells R_4 to 1st A; abdomen black, the hypopygium more brightened.

Male.—Length, about 5.5 millimeters; wing, 6.

Female.—Length, about 6.5 to 6.8 millimeters; wing, 6 to 6.2.

Rostrum and palpi black. Antennæ short in both sexes; scape black; pedicel and first flagellar segment light yellow; remainder of flagellum black; flagellar segments oval, becoming more slender and elongate outwardly. Head black.

Pronotum dark brown. Mesonotal præscutum reddish brown, darkened in front and on sides; scutum reddish brown; scutellum and postnotum dark brown, sparsely pruinose. Pleura black. Halteres weakly suffused with dusky, the base of stem restrictedly paler. Legs with the coxæ brownish black; trochanters obscure yellow, the tips narrowly darkened; femora yellow, with a narrow and very indistinct darker ring just before the tip; remainder of legs yellow; setæ of legs very long and conspicuous. Wings (Plate 1, fig. 18) much broader in male than in female, in the former widest opposite the termination of vein 2d A; ground color pale yellow, the basal cells slightly washed with dusky; a heavy dark brown pattern that is chiefly confined to the vicinity of the veins, the interspaces being immaculate; the chief markings are as follows: Postarcular; origin of Rs; along cord and centering about the supernumerary crossvein in cell R_3, these markings narrowly bordered by yellow and subtended

[8] Tidj. voor Ent. 51 (1913) pl. 17, fig. 16.

on either side by smaller spots; outer end of cell 1st M_2 and fork of M_{1+2} restrictedly darkened; a series of small subterminal spots in cells R_4 to 1st A, respectively, placed just cephalad of the vein and slightly back from the margin, the vein beyond this point more heavily darkened to the wing border; extreme axilla weakly darkened; veins pale, darker in the clouded areas. Venation: Supernumerary crossvein in cell R_3 oblique, placed at near two-thirds the length of cell; cell M_1 shallow, subequal to its petiole; cell 1st M_2 subrectangular, a little widened outwardly; m-cu about one-half its length beyond fork of M; vein 2d A bent rather strongly to border, simple in both sexes.

Abdomen black, the hypopygium more brightened. Male hypopygium (Plate 2, fig. 32) with the outer dististyle, *od*, nearly straight, unequally bidentate at tip, the terminal spine much stouter and more strongly curved than the outer subapical one.

Habitat.—Assam (Khasi Hills).

Holotype, male, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*). Allotopotype, female. Paratopotypes, several females.

The nearest relative of the present fly would appear to be *Limnophila* (*Dicranophragma*) *venustipennis* Alexander (*pulchripennis* Brunetti, preoccupied), of the eastern Himalayas. The present species is distinguished by the simple 2d anal vein of both sexes and the nature of the wing pattern, especially the geminate smaller spots subtending the larger dark areas along the cord and in the outer radial field. It seems virtually certain that Brunetti had two species confused in his original description. The true *venustipennis* is discussed in some detail below.

LIMNOPHILA (DICRANOPHRAGMA) VENUSTIPENNIS Alexander.

Dicranophragma pulchripennis BRUNETTI, Fauna Brit. India, Dip. Nematocera (1912) 524 (preoccupied in *Limnophila*).

Limnophila (*Dicranophragma*) *venustipennis* ALEXANDER, Insec. Inscit. Menst. 9 (1921) 180.

Several females that I am referring to this species are from Cherrapunji, Khasi Hills, Assam, altitude 4,000 to 5,000 feet, taken at light, August, 1935, by Mr. S. Sircar. The wings of the female are much narrower than in the males, while the 2d anal vein is simple. In the males of the type series of *pulchripennis* vein 2d A is forked near its outer end, as described by Edwards [9] and shown by a paratypical specimen in my collection. The proximal spur of this fork is surrounded by the most basal

[9] Rec. Indian Mus. 26 (1924) 303.

of the marginal darkened areas of the wing. Brunetti describes the thorax as being dark-colored, but the ground color is dark brown, the surface chiefly covered by more reddish brown stripes.

ERIOPTERINI

TRENTEPOHLIA (MONGOMA) SUBTENERA sp. nov. Plate 1, fig. 19.

Allied to *tenera;* general coloration of mesonotum almost uniformly dark brown, the scutellum clear yellow; femoral tips and tibial bases narrowly but conspicuously whitened; tibial tips broadly and conspicuously snowy white, the amount including approximately the distal fourth of the segment; tarsi snowy white; wings pale gray; veins R_{1+2}, R_2, and R_{3+4} subequal; inner end of cell R_5 lying a little more distad than that of cell M_3.

Female.—Length, about 8 millimeters; wing, 6.3.

Rostrum obscure yellow; palpi black. Antennæ black throughout; flagellar segments oval, the outer two segments shorter; verticils shorter than the segments and only a little more conspicuous than the normal pubescence. Head dark gray; anterior vertex reduced to a linear strip.

Pronotum above dark brown. Mesonotal præscutum and scutum almost uniformly dark brown, the median area of the latter a little paler; scutellum clear light yellow, the parascutella slightly darker; postnotum yellowish brown. Pleura with the dorsal and anterior sclerites infuscated, the posterior portions adjoining the wing root more yellow. Halteres dusky. Legs with the coxæ brownish yellow, the fore coxæ a trifle darker; trochanters yellow; femora dark brown, the tips rather narrowly but conspicuously white, the amount subequal on all legs and involving approximately one-ninth of the segment; tibiæ dark brown, the bases narrowly but conspicuously white, in degree about one-half as extensive as the femoral tips, passing gradually into the dark ground color; tibial tips broadly, conspicuously, and abruptly snowy white, including approximately one-fourth the total length of the segment; tarsi snowy white, the terminal segment weakly darkened; tips of posterior tibiæ very slightly enlarged and with the snowy-white vestiture more erect and conspicuous; posterior femora with about ten small spines in a linear row near base. Wings (Plate 1, fig. 19) relatively narrow, uniformly pale gray, cell Sc a trifle darker; veins pale brown. A scattered series of about eight trichia on vein R_5. Venation: Sc_1 ending just before the proximal or cephalic end of R_2; Rs a little longer than the basal section of R_5 and about in alignment with it; R_{2+3+4} long, gently sinuous; R_{1+2}, R_2, and R_{3+4} subequal; R_3 oblique; cell

1st M_2 gradually widened outwardly; inner end of cell R_5 lying a trifle more distad than that of cell M_3; m-cu close to fork of M; apical fusion of veins Cu_1 and 1st A relatively extensive, longer than the basal section of M_{1+2}.

Abdominal tergites dark brown, the basal segments a little paler; sternites obscure yellow to brownish yellow.

Habitat.—Assam (Khasi Hills).

Holotype, female, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*).

By all keys to the Oriental species of *Trentepohlia* the present fly runs to *Trentepohlia* (*Mongoma*) *tenera* (Osten Sacken), from which it differs in the coloration of the legs and the venation, especially the length of veins R_{3+4}, basal section of M_3, and apical fusion of Cu_1 and 1st A. Brunetti placed his species *pallidiventris* [10] as a synonym of *tenera*, but this is evidently an error. The species has the femora uniformly darkened beyond the base and the tibiæ whitened only at the tips.

TRENTEPOHLIA (MONGOMA) WALSHIANA sp. nov. Plate 1, fig. 20.

Thorax entirely orange, immaculate; antennæ black throughout; head gray, the posterior portion of vertex and the occiput paling to brown; halteres pale, the knobs light yellow; legs brownish black, the tips of tibiæ and the tarsi paling to yellow; wings whitish subhyaline, the prearcular and costal fields clear light yellow; a restricted dark pattern, including the wing tip; abdomen black, the segments restrictedly variegated by yellow.

Female.—Length, about 10 to 11 millimeters; wing, 9 to 10.

Rostrum dark brown to black; palpi black. Antennæ with scape and pedicel dark brown to black; flagellum black; flagellar segments cylindrical, relatively elongate. Front and anterior vertex light gray, the posterior vertex dark gray in front, paling to brown behind and on the occiput; anterior vertex reduced to a narrow strip, its posterior portion strongly carinate, the ridge continued caudad onto the posterior vertex.

Cervical sclerites light brown. Pronotum and mesonotum uniformly bright orange, the pleura a trifle more yellow. Halteres obscure brownish yellow, the base of stem narrowly yellow, the apex of knob clear light yellow. Legs with the coxæ and trochanters yellow; femora dark brown to brownish black, the extreme bases vaguely brightened; tibiæ pale brown to brownish yellow, becoming brighter at outer ends, the forepair more ex-

[10] Fauna Brit. India Dip. Nematocera (1912) 481; Rec. Indian Mus. 15 (1918) 312.

tensively brightened; tarsi light brownish yellow; femora with about four to twelve small erect spines, fewest on posterior femora. Wings (Plate 1, fig. 20) whitish subhyaline, the prearcular region and cells C and Sc clear light yellow; stigmal area small and restricted, triangular in outline, brownish yellow; wing tip narrowly infuscated, including cells R_3 to 2d M_2; veins R_2, cord, and Cu narrowly seamed with brown; veins brown, a little darker in the clouded areas, clear yellow in the flavous portions. Venation: R_2 a short distance before fork of R_{3+4}, its cephalic or proximal end faint to ill-defined in the stigmal area; basal section of M_3 slightly angulated; m-cu close to or shortly before fork of M; apical fusion of Cu_1 and 1st A punctiform.

Abdomen chiefly black, with faint bluish reflections, the dorsopleural region pale; lateral margins of tergites and basal lateral spots on sternites restrictedly yellow; in cases the sternal pale spots are more extensive, forming nearly complete crossbands on the basal rings of the segments. Ovipositor and genital segment deep yellow.

Habitat.—Sumatra (south).

Holotype, female, Boekit Jtam, Benkoelen, altitude 1,000 to 2,000 feet, June 11 to 15, 1935 (*Walsh*). Paratopotype, sex?

I take great pleasure in naming this beautiful crane fly in honor of the collector, Mrs. M. E. Walsh. The nearest described species is *Trentepohlia* (*Mongoma*) *auricosta* Alexander (western Java), which differs conspicuously in the coloration of the body, and the details of pattern of the legs and wings.

TRENTEPOHLIA (MONGOMA) EPHIPPIATA sp. nov. Plate 1, fig. 21.

General coloration of thorax black, the lateral and humeral portions of præscutum yellow; halteres brownish black; femora and tibiæ brownish black, the tips of the latter and the tarsi paling to yellow; wings whitish subhyaline, the prearcular and costal regions not conspicuously brightened; a weak darkened pattern, including the wing tip, stigma, and seams along vein Cu and origin of Rs; abdomen black, the basal rings of the intermediate sternites narrowly obscure yellow.

Female.—Length, excluding head, about 8 millimeters; wing, 7.4.

Head broken.

Cervical sclerites blackened. Pronotum brownish black above, obscure yellow basally on sides. Mesonotal præscutum obscure yellow on humeral and lateral portions, the entire disk covered by three confluent brownish black stripes that cross the suture

and include the scutal lobes; scutellum and postnotum brownish black. Pleura brownish black, the dorsopleural membrane and meral region a little paler. Halteres brownish black, the base of stem narrowly yellow. Legs with the fore and middle coxæ black, the posterior coxæ and all trochanters obscure yellow; femora brownish black, the extreme bases restrictedly brightened; tibiæ black, the distal ends paling to obscure yellow or brownish yellow; armature of legs including a series of four long erect setæ on distal fourth of posterior tibiæ. Wings (Plate 1, fig. 21) whitish subhyaline, including the prearcular region and basal half of costal field; outer portions of cells C and Sc a little more yellowish; stigma conspicuous, dark brown; wing tip weakly and rather narrowly infuscated; narrow but conspicuous brown seams along vein Cu and at origin of Rs, the remainder of cord very insensibly darkened; veins brown, paler in the costal and prearcular fields. Venation: R_2 about one-third its length before the fork of R_{3+4}; m-cu close to fork of M; inner end of cell M_3 a little more basad than that of cell R_5; apical fusion of veins Cu_1 and 1st A punctiform.

Abdomen black, the pleural membrane paler; basal rings of intermediate sternites narrowly obscure yellow. Ovipositor and genital segment yellow.

Habitat.—Sumatra (south).

Holotype, female, Tandjong Sakti, Benkoelen, altitude 1,650 to 2,000 feet, June 11 to 20, 1935 (*Walsh*).

Trentepohlia (*Mongoma*) *ephippiata* is allied to species such as *T.* (*M.*) *auricosta* Alexander, *T.* (*M.*) *flavicollis* Edwards, *T.* (*M.*) *hainanica* Alexander, and *T.* (*M.*) *walshiana* sp. nov., differing conspicuously in the coloration of the body. The blackened discal saddle of the mesonotal præscutum is distinctive.

TRENTEPOHLIA (TRENTEPOHLIA) STREPENS sp. nov. Plate 1, fig. 22.

Size very large; legs long and powerful; general coloration ferruginous yellow, the thorax unmarked; head gray, the vertex strongly carinate; legs yellow, the femoral tips, tibial bases, and tibial tips conspicuously blackened; wings pale yellow, the costal and outer radial fields more saturated yellow; restricted dark seams on veins R_3, basal section of M_{1+2}, m-cu, and fork of $R_5 + M_{1+2}$; abdomen yellow, the subterminal segments slightly infuscated.

Male.—Length, about 8 millimeters; wing, 7. Posterior leg, femur, 12; tibia, 12.5; tarsus, 8.

Rostrum obscure yellow; palpi brownish black. Antennæ brownish black, the scape a little brightened; flagellar segments

cylindrical, with dense dark pubescence. Head gray; anterior vertex narrow, the carina conspicuous.

Cervical sclerites obscure yellow. Thorax entirely ferruginous-yellow, the surface somewhat polished. Halteres yellow throughout. Legs with the coxæ and trochanters yellow; femora yellow, the tips rather broadly and very conspicuously blackened; tibiæ obscure yellow, the bases narrowly darkened, the tips broadly blackened; tarsi brownish black; legs unusually long and powerful, as shown by the measurements given above; femora with scattered erect setæ over the entire length. Wings (Plate 1, fig. 22) pale yellow, the costal and outer radial field more saturated yellow; a restricted dark pattern, including a narrow brown seam on vein R_3 and somewhat darker seams on posterior cord and fork of R_5+M_{1+2}; veins yellow, darkened in the clouded areas. Venation: m-cu shortly before fork of M; distal section of Cu_1 strongly arcuated, its apical fusion with 1st A slight.

Abdomen yellow, the subterminal segments slightly infuscated.

Habitat.—Sumatra (south).

Holotype, male, Tandjong Sakti, Benkoelen, altitude 1,650 to 2,000 feet, June 21 to 30, 1935 (*Walsh*).

Trentepohlia (*Trentepohlia*) *strepens* is the largest species of the subgenus so far made known, as is well shown by the leg measurements given above. It is allied to *T.* (*T.*) *holoxantha* Alexander and *T.* (*T.*) *mcgregori* Alexander, especially to the latter, differing especially in the major size and in the distinctive pattern of the wings.

MOLOPHILUS KHASICUS sp. nov. Plate 1, fig. 23; Plate 2, fig. 33.

Belongs to the *gracilis* group and subgroup; general coloration brown; antennæ (male) short; wings brownish yellow, the macrotrichia dark brown; abdomen dark brown, the hypopygium more yellowish; male hypopygium with all three lobes of basistyle obtuse at tips, with setæ throughout their lengths; three dististyles, all simple rods that are very markedly sinuous, the tips acute or subacute; intermediate and inner styles with spinulæ on distal third.

Male.—Length, about 3.8 millimeters; wing, 4.4.

Rostrum dark brown; palpi black. Antennæ (male) short, if bent backward ending far before the wing root; scape and pedicel light yellow, flagellum dark brown, flagellar segments short-cylindrical, with long conspicuous verticils. Head dark brownish gray.

Pronotum brownish black. Mesonotal præscutum dark brown, with a faint reddish cast, somewhat darker colored laterally and on extreme cephalic portion; scutum and scutellum brown; mediotergite darker colored. Pleura dark brown, with a vague paler longitudinal stripe across the dorsal sternopleurite and ventral pteropleurite, beginning behind the posterior coxæ. Halteres pale yellow throughout. Legs with the coxæ and trochanters brownish yellow; remainder of legs brownish yellow, with dark-colored setæ that obscure the ground; outer tarsal segments more uniformly dark brown. Wings (Plate 1, fig. 23) with a strong brownish yellow tinge, the veins darker brown; macrotrichia dark brown; costal fringe long and dense. Venation: R_2 about opposite r-m; m-cu about one-half the petiole of cell M_3; vein 2d A ending opposite caudal end of m-cu.

Abdomen dark brown, the large hypopygium more yellowish. Male hypopygium (Plate 2, fig. 33) with all three lobes of basistyle, *b*, simple and nonspinous, with setæ to their tips. Three dististyles, the outer, *od*, a strongly sinuous, slender rod, its distal third straight; intermediate style, *md*, a simple rod, its distal third very strongly bent and thence narrowed into a spine, this portion of style bearing a linear row of slender teeth; inner style, *id*, a strongly curved simple rod, its distal third with a series of five or six strong spinules. Phallosomic plate oval in outline.

Habitat.—Assam (Khasi Hills).

Holotype, male, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*).

The *Molophilus* fauna of the Himalayan region is still very poorly known. From the few species hitherto described the present fly is readily told by the unusually large and complicated male hypopygium, in conjunction with the short antennæ of the male sex. The most generally similar species seems to be *Molophilus genitalis* (Brunetti), which has the male hypopygium of entirely different conformation.[11]

TOXORHINA (CERATOCHEILUS) MESORHYNCHA sp. nov. Plate 1, fig. 24; Plate 2, fig. 34.

General coloration of mesonotal præscutum dark brown, the lateral margins gray; rostrum much shorter than the wing; anterior vertex wide; legs brownish black; wings pale gray, veins light brown; no macrotrichia on Rs or its anterior branch; abdomen brownish black; male hypopygium with the dististyle pro-

[11] Edwards, F. W., Rec. Indian Mus. 26 (1924) 300.

duced into a long, straight, apical point, on outer margin at near one-third the length bearing a pale fleshy spine.

Male.—Length, excluding rostrum, about 6 millimeters; wing, 5.3; rostrum, 3.5.

Rostrum much shorter than the wing, black throughout. Antennæ black, the first segment a little pruinose but not at all brightened. Head brown, the front, anterior vertex, and broad posterior orbits light gray; anterior vertex unusually broad, approximately one-third the width of the head at this point, or equal to the visible diameter of either eye.

Pronotum dark brown. Mesonotal præscutum with the dorsum largely occupied by three, confluent, dark brown stripes that restrict the dull gray ground color to the humeral and lateral portions; scutal lobes dark brown, the median area more grayish; scutellum and postnotum gray. Pleura bicolorous, the dorsopleural membrane and dorsal sclerites much darker than the sternopleurite and meral areas, the dark color continued caudad beneath the wing root and including the lateral and caudal portions of the mediotergite. Halteres obscure yellow. Legs with the coxæ gray; trochanters yellowish brown; remainder of legs brownish black. Wings (Plate 1, fig. 24) with a uniform, pale gray tinge; veins light brown. No macrotrichia on Rs or its anterior branch; posterior branch with a series of about twenty on distal section of vein R_5; seven or eight trichia on outer section of vein M_{1+2}. Venation: Sc_1 ending just beyond origin of Rs, the latter a little more than one-half as long as its gently sinuous anterior branch; m-cu close to fork of M.

Abdomen brownish black, the hypopygium very little brighter. Male hypopygium (Plate 2, fig. 34) with the basistyle, *b*, provided with a blunt lobe on mesal face near base, this lobe tipped with numerous long coarse setæ. A single, entirely pale dististyle, *d*, produced into a long straight apical point; on outer margin at near the basal third with a slender, gently curved, fleshy spine. Arms of ædeagus, *a*, relatively short.

Habitat.—Assam (Khasi Hills).

Holotype, male, Cherrapunji, altitude 4,000 to 5,000 feet, August, 1935, at light (*Sircar*).

Toxorhina (*Ceratocheilus*) *mesorhyncha* is readily told from *T.* (*C.*) *brevifrons* (Brunetti), likewise from Assam, by the wide anterior vertex, short rostrum, uniformly darkened antennæ, and darkened abdominal sternites. I have provided below a redescription of the holotype specimen of *brevifrons*.

TOXORHINA (CERATOCHEILUS) BREVIFRONS (Brunetti).

Conithorax brevifrons BRUNETTI, Rec. Indian Mus. 15 (1918) 300.

The holotype, a female, was taken above Tura, Garo Hills, Assam, altitude 3,500 to 3,900 feet, August, 1917, by Dr. Stanley Kemp. I am indebted to Dr. H. Singh Pruthi for the opportunity to reëxamine this specimen and have provided additional notes concerning certain critical points.

Female.—Length, excluding rostrum, about 7 millimeters; wing, 6.3; rostrum, about 8.

Rostrum elongate, exceeding the remainder of body, black throughout. Antennæ black, the small scape obscure yellow. Anterior vertex very narrow, only a little wider than the antennal pedicel, the sides concave; head beneath a little wider than on the vertex. Head brownish gray, the anterior vertex and orbits clear light gray.

Mesonotum dark brown, the humeral region and narrow lateral margins of the præscutum brighter; median region of the scutum paler than the lobes. Pleura dark dorsally, the dorsal portion of the sternopleurite more brownish yellow. Halteres relatively short, dusky. Legs dark brown, the femoral bases restrictedly paler. Wings with a faint brown tinge; veins dark brown. Macrotrichia of veins relatively abundant, there being a series of about five on Rs; apparently lacking on the distal section of M_4; a single puncture of R_{2+3+4} shortly beyond origin; a series of at least thirty trichia on distal section of R_5; about eight on basal section of R_5. Venation: Sc_1 ending about opposite two-fifths the length of Rs, Sc_2 before the origin of Rs; Rs and the two sections of R_5 in sinuous alignment; R_{2+3+4} relatively long, ending beyond the level of r-m; cell 1st M_2 closed, relatively large; m-cu just beyond the fork of M; approximation of veins Cu and 1st A relatively slight.

Abdominal tergites dark brown, the sternites yellowish brown; genital segment obscure brownish yellow. Ovipositor with the tergal valves very long and slender, the basal three-fourths or more straight, the apex gently upcurved; external valves more compressed, horn-colored.

The sides of the anterior vertex are strongly concave, not convex, as indicated by Brunetti. Two of the figures given by Brunetti (loc. cit., pl. 8, figs. 12, 13) as representing *Teucholabis angusticapitis* Brunetti pertain to a species of *Ceratocheilus*, presumably *C. latifrons* (Brunetti).

ILLUSTRATIONS

[*a*, Ædeagus; *b*, basistyle; *d*, dististyle; *g*, gonapophysis; *i*, interbase; *id*, inner dististyle; *ig*, inner gonapophysis; *md*, middle dististyle; *od*, outer dististyle; *og*, outer gonapophysis; *s*, sternite; *t*, tergite; *vd*, ventral dististyle.]

PLATE 1

FIG. 1. *Tipula* (*Schummelia*) *modica* sp. nov., venation.
2. *Tipula* (*Schummelia*) *pergrata* sp. nov., venation.
3. *Tipula* (*Vestiplex*) *tuta* sp. nov., venation.
4. *Limonia* (*Geranomyia*) *meracula* sp. nov., venation.
5. *Limonia* (*Geranomyia*) *offirmata* sp. nov., venation.
6. *Antocha* (*Antocha*) *plumbea* sp. nov., venation.
7. *Antocha* (*Antocha*) *basivena* sp. nov., venation.
8. *Antocha* (*Antocha*) *scelesta* sp. nov., venation.
9. *Antocha* (*Antocha*) *sparsipunctata* sp. nov., venation.
10. *Antocha* (*Orimargula*) *præscutalis* sp. nov., venation.
11. *Helius* (*Helius*) *lectus* sp. nov., venation.
12. *Helius* (*Helius*) *selectus* sp. nov., venation.
13. *Orimarga* (*Orimarga*) *distivenula* sp. nov., venation.
14. *Orimarga* (*Orimarga*) *subbasalis* sp. nov., venation.
15. *Nipponomyia khasiana* sp. nov., venation.
16. *Adelphomyia* (*Adelphomyia*) *discalis* sp. nov., venation.
17. *Adelphomyia* (*Adelphomyia*) *subnebulosa* sp. nov., venation.
18. *Limnophila* (*Dicranophragma*) *multigeminata* sp. nov., venation.
19. *Trentepohlia* (*Mongoma*) *subtenera* sp. nov., venation.
20. *Trentepohlia* (*Mongoma*) *walshiana* sp. nov., venation.
21. *Trentepohlia* (*Mongoma*) *ephippiata* sp. nov., venation.
22. *Trentepohlia* (*Trentepohlia*) *strepens* sp. nov., venation.
23. *Molophilus khasicus* sp. nov., venation.
24. *Toxorhina* (*Ceratocheilus*) *mesorhyncha* sp. nov., venation.

PLATE 2

FIG. 25. *Tipula* (*Schummelia*) *pergrata* sp. nov., male hypopygium.
26. *Limonia* (*Geranomyia*) *fumimarginata* sp. nov., male hypopygium.
27. *Antocha* (*Antocha*) *basivena* sp. nov., male hypopygium.
28. *Antocha* (*Antocha*) *scelesta* sp. nov., male hypopygium.
29. *Nipponomyia khasiana* sp. nov., male hypopygium.
30. *Adelphomyia* (*Adelphomyia*) *discalis* sp. nov., male hypopygium.
31. *Adelphomyia* (*Adelphomyia*) *subnebulosa* sp. nov., male hypopygium.
32. *Limnophila* (*Dicranophragma*) *multigeminata* sp. nov., male hypopygium.
33. *Molophilus khasicus* sp. nov., male hypopygium.
34. *Toxorhina* (*Ceratocheilus*) *mesorhyncha* sp. nov., male hypopygium.

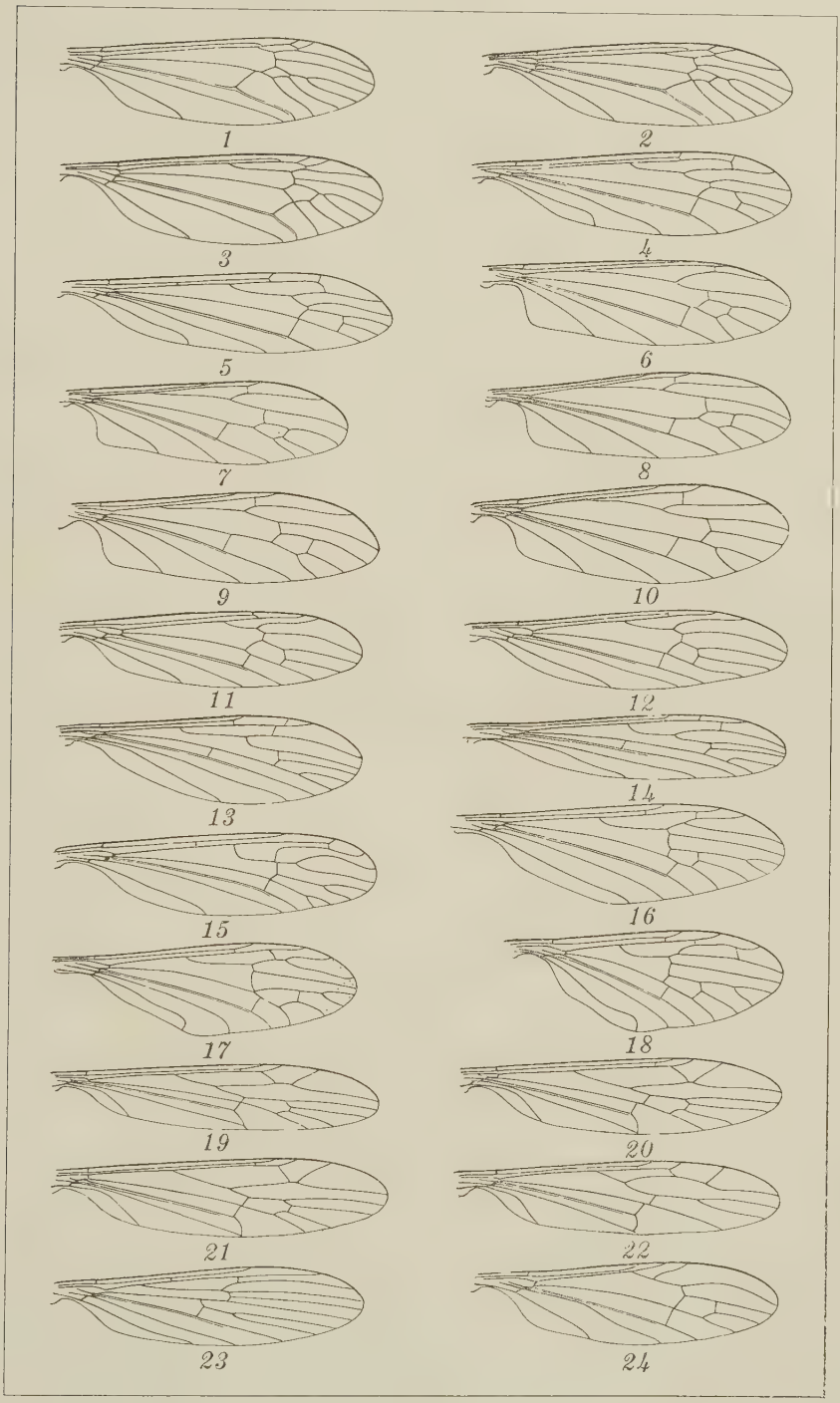

PLATE 1.

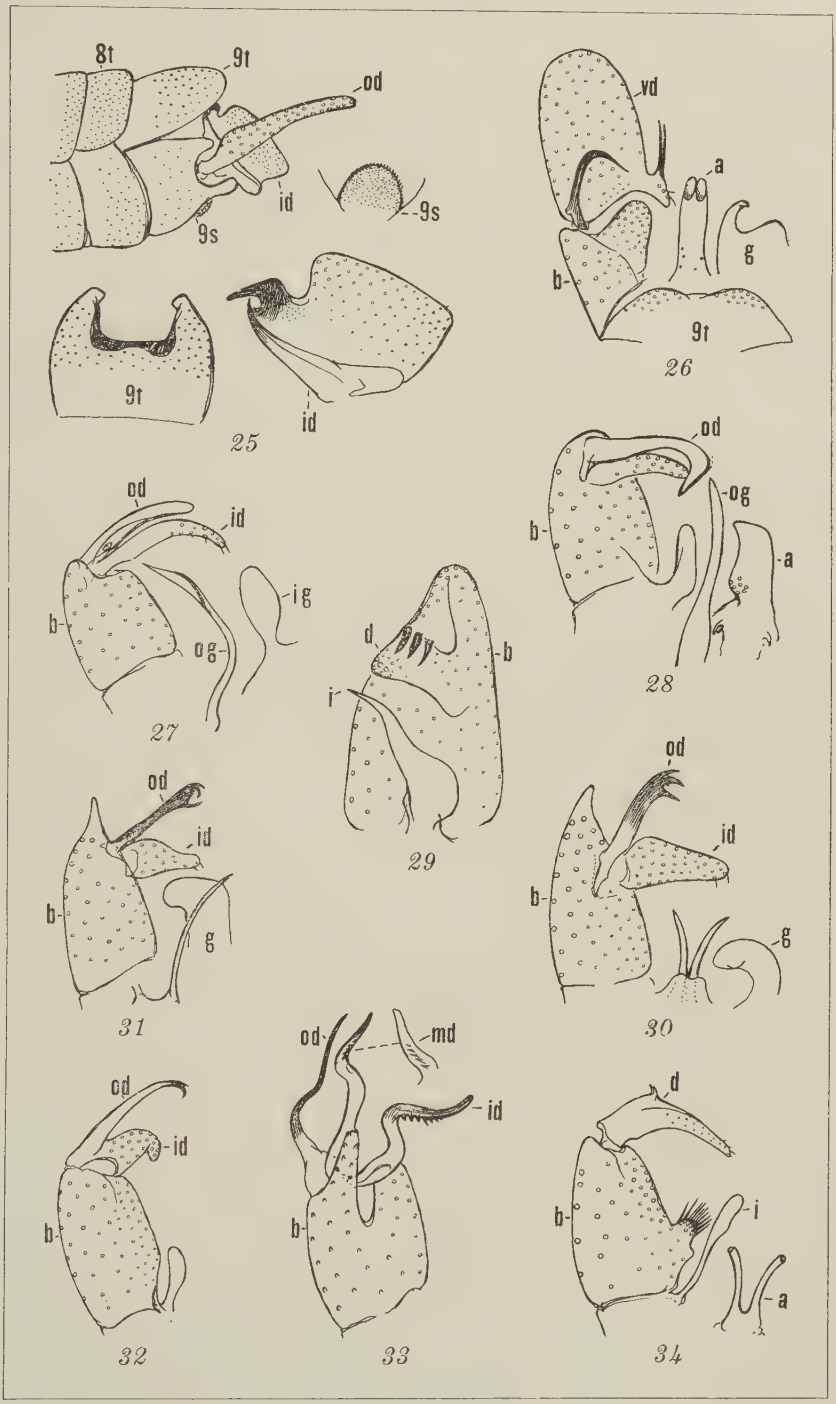
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PLATE 2.

NOTES ON PHILIPPINE MOSQUITOES, VI

THE PUPAL CHARACTERS OF ANOPHELINES OF THE SUBGENUS MYZOMYIA

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TWENTY-FIVE PLATES

The material upon which this paper is based was collected mainly in Luzon. *Anopheles parangensis* and one *A. indefinitus* found breeding with *parangensis* are from Davao, Mindanao; and two *A. minimus* var. *flavirostris* are from Itbayat Islands, Batanes.[1]

Among Philippine *Anopheles* some closely related varieties and species are easily separated in the egg stage (as the local varieties of *sinensis*) ; others are very difficult if not impossible to differentiate by the characters of the eggs, but are readily separated by the characters of the larvæ (such as *Anopheles hyrcanus* var. *nigerrimus* and *A. hyrcanus* var. *lesteri*) ; while still others, which are very much alike in the larval stage, possess marked differences in the pupæ (as *A. hyrcanus* var. *pseudosinensis* and *A. hyrcanus* var. *lesteri;* or *A. leucosphyrus* and *A. leucosphyrus* var. *balabacensis*). It would seem, therefore, that the conclusions of Hackett (1934, 1935) and other European workers with regard to the reliability of egg characters (because they are genotypic in nature) in the differential diagnosis of the varieties of *maculipennis,* and the claim they make that morphological differences in the larvæ and adults are unstable (therefore, unreliable) because they can be so modified by en-

[1] To the many persons and entities mentioned in the previous parts of these Notes, I have to add Major G. C. Dunham, formerly Health Adviser to the Governor General (now High Commissioner), who gave to the malaria section of the Bureau of Health specimens of *A. minimus* var. *flavirostris,* which the Major himself collected in the Batanes; and Mr. Andres Nono, civilian field director of the malaria control work at Iwahig and Davao Penal Colonies, who kindly gave me specimens of *parangensis* and other rare species from Palawan and Mindanao Islands.

vironment as to obscure the genetic differences, cannot be completely applied to the classification of Philippine species of *Anopheles*. It seems that a consideration of the characters in all stages, whenever possible, should be the basis of classification.

Unlike the species of the subgenus *Anopheles*, which can be readily separated in the pupal stage, many of the forms of the subgenus *Myzomyia* do not possess marked specific characters. The groups, however, are quite easily separable, as shown in the following key:

Key to groups of the subgenus Myzomyia, based on pupal characters.

1. Paddle hair short, straight; *A*–VII blunt, at most 0.4676 mm long, usually much shorter ..... Group *Neomyzomyia*.
   Paddle hair long, curved; *A*–VII distinctly pointed, at least 0.5845 mm long, usually much longer ..... 2.
2. Hair *C*–II branched more than 10..... Group *Myzomyia*.
   Hair *C*–II branched less than 10..... 3.
3. *A*–VI and *A*–VII more than half the lengths of segments VII and VIII, respectively (at least 0.6 mm long, usually much longer); *K*–I usually simple, sometimes split into 2..... Group *Pseudomyzomyia*.
   A–VI and *A*–VII half or less the lengths of the succeeding segments, respectively (at most less than 0.6 mm long, usually much shorter); *K*–I usually 5-branched, range 3 to 9..... Group *Neocellia*.

In Table 1 the variations in the branching of the different hairs are shown.

The scheme used in designating the hairs and other parts of the pupa is shown in Plates 1 and 2. This is adapted from Senevet (1930–1932) as modified by Christophers (1933). Reference to the metathorax is by the capital letter "M" and to the abdominal segments by Roman numerals. Hairs on the metathorax and abdominal segment I may be referred to without the "M" or the "I" as *R*, *T*, etc., or they may be written *R*–M, *T*–I, etc. The spines and other hairs are referred to with the corresponding segments as *A*–II, *B*–V, etc., but *C'*–VI may be written merely *C'*, because this hair is present only on segment VI.

In the subgenus *Myzomyia* hair *S* is invariably branched and is the shortest and most internal of the three hairs situated at the anterolateral border of abdominal segment I. It is posterior to *T* but anterior to *U* in position. Senevet's conventional illustrations for *subpictus* Grassi and *vagus* Dönitz (1931, p. 40 and p. 74, respectively) are somewhat misleading, especially because his corresponding descriptions (p. 41 and p. 75, respec-

tively), "*S*, moyenne, 3–4 branches" for *subpictus*, and "*S* . . ., tres longue et simple" for *vagus*, do not agree with his illustrations. In a subsequent paper (1932) the character of *S* for *vagus* which Senevet presents is more in agreement with that for *vagus* var. *limosus* of the Philippines, although the unusual simple *S* and 4-branched *T* of his specimen No. 4 have not been duplicated by any of the many specimens I have examined of the local species of the group *Pseudomyzomyia*.

For the local species of the subgenus *Myzomyia* the characters of *A*, *B*, and *C* are of specific and group values in many cases; in some very closely allied species *A* alone indicates differences between the forms. Branching of *A*, particularly *A*–VII, is common to all species except one in the group *Neomyzomyia;* while splitting into two of *A*–VII in group *Myzomyia* (especially in *mangyanus*) occurs with such frequency as to be considered a normal, though less common, peculiarity; but in the other groups—*Neocellia* and *Pseudomyzomyia*—this happens very rarely and may therefore be taken as an abnormality. Duplication of a spine sometimes occurs. Normally there is a progressive increase in the length of the spines from the anterior to the posterior segments, the longest being *A*–VII. Sometimes, however, *A*–VI and, more rarely, *A*–V are as long as or even longer than *A*–VII. Again, a spine that is ordinarily short may attain a length entirely beyond its normal proportions, or vice versa. But such abnormalities affect, so far as I have noted, only the spine of one side of a segment. Group *Pseudomyzomyia* possesses the longest spines, as can be seen in Table 2.

Of the parts of the paddle, the denticles (their relative sizes, and the extent of the external border they occupy), the presence or absence of accessory denticles on the anterolateral border of the paddle, and the length of the paddle hair are useful in differential diagnosis.

GROUP NEOMYZOMYIA

(Excluding *kolambuganensis* of which we have no pupal material.)

As mentioned by Christophers (1933), and others, this group differs greatly from the other groups in the subgenus *Myzomyia,* and is similar to the subgenus *Anopheles* in having short paddle hair, and short, blunt spines.

TABLE 1.—*Variations in the branching of pupal hairs in the subgenus Myzomyia.*

Part.	Hairs.	Group *Myzomyia*.						Group *Neomyzomyia* (part).			
		Anopheles filipinæ.		*Anopheles flavirostris.*		*Anopheles mangyanus.*		*Anopheles kochi.*		*Anopheles tesselatus.*	
		Range.	Usual.	Range.	Usual.	Range.	Usual.	Range.	Usual.	Range.	Usual.
Metathorax	*R*	4- 6	5	4- 8	5	4- 9	5	2- 3	2	3- 5	3
Do	*P*	2- 6	4	3- 7	5	3- 6	4	1- 2	2	2- 4	3
Do	*O*	1- 4	2	2- 5	4	2- 5	3	2- 3	2	1- 2	1
Abdominal segment I	*H*	1- 2	1	1- 3	2	1- 3	2	1- 4	2	1- 1	1
Do	*K*	3- 8	5	6-11	7	3- 8	6	3- 4	3	5- 6	5
Do	*L*	4-12	8	7-11	8	4-10	5	4- 5	4	4- 5	5
Do	*M*	1- 8	2	1- 3	3	1- 4	2	2- 3	3	3- 5	4
Do	*S*	4- 8	5	6-10	7	3- 9	5	3- 5	3	4- 9	5
Do	*T*	1- 3	2	2- 5	3	1- 4	3	2- 3	2	4- 7	5
Do	*U*	3- 8	4	3- 6	4	2- 5	3	1- 1	1	1- 2	1
Abdominal segment II	*C*	10-18	14	16-33	21	12-25	15	9-14	13	9-16	12
Do	1	1- 2	1	1- 2	1	1- 4	2	1- 2	2	3- 5	4
Do	1	3- 9	5	5-10	8	4- 9	6	2- 5	3	3- 6	5
Do	2	3- 8	5	5- 8	6	3- 7	5	2- 4	2	4- 6	5
Do	2	2- 8	6	6-14	7	3- 9	5	3- 4	3	3- 5	3
Do	3	2- 5	3	5- 9	6	3- 8	5	1- 2	2	1- 3	2
Do	4	4- 8	6	6-13	10	3- 8	6	4- 6	5	5-12	6
Do	5	1- 1	1	1- 1	1	1- 1	1	1- 1	1	1- 1	1
Abdominal segment III	*B*	7-15	11	10-22	14	8-18	11	6-10	10	9-12	11
Do	*C*	8-17	10	8-18	13	11-20	16	5- 7	6	11-13	11
Do	1	3- 8	5	3- 9	5	2- 9	5	1- 2	2	4- 6	5
Do	2	3- 9	5	4- 9	7	2- 7	4	2- 4	4	3- 5	4
Do	3	2- 6	4	4- 9	7	4- 9	6	1- 2	2	1- 2	2
Do	4	4-10	8	7-14	10	5-10	8	3- 4	4	6- 8	7
Do	5	1- 1	1	1- 1	1	1- 1	1	1- 1	1	1- 1	1

Abdominal segment IV	*B*	6–13	7	8–13	10	6–11	9	6– 9	7	8–14	12
Do	*C*	6–13	8	5–13	8	8–18	11	3– 4	3	8–12	10
Do	1	4– 6	5	4– 7	5	2– 6	4	1– 1	1	2– 5	4
Do	2	2– 6	3	2– 5	3	1– 4	2	2– 4	3	3– 5	4
Do	3	4–10	6	4– 9	7	4– 8	7	4– 7	6	4– 7	5
Do	4	5–10	7	5–10	8	3– 9	7	3– 3	3	5– 7	5
Do	5	1– 1	1	1– 1	1	1– 1	1	1– 1	1	1– 1	1
Abdominal segment V	*B*	3–11	8	7–11	9	4– 9	7	3– 5	5	8–12	11
Do	*C*	2– 7	3	2– 6	3	1– 7	3	2– 3	2	6– 9	6
Do	1	2– 6	3	3– 6	4	2– 4	3	1– 1	1	3– 5	3
Do	2	2– 5	4	3– 6	5	1– 5	3	2– 3	3	2– 5	4
Do	3	2– 4	3	2– 5	3	2– 6	3	2– 2	2	2– 5	3
Do	4	3– 7	6	4–10	7	3– 7	5	3– 4	3	5– 7	5
Do	5	1– 1	1	1– 1	1	1– 2	1	1– 1	1	1– 1	1
Abdominal segment VI	*B*	3– 8	6	6–10	8	4– 9	5	3– 4	3	5–10	7
Do	*C*	2– 4	2	2– 4	3	1– 4	3	1– 1	1	5– 8	6
Do	*C'*	2– 4	3	2– 4	3	1– 4	3	1– 1	1	1– 3	2
Do	1	2– 4	2	2– 5	3	1– 4	2	1– 2	1	3– 5	3
Do	2	1– 3	2	2– 3	3	1– 3	2	2– 2	2	1– 5	3
Do	4	4– 7	5	4– 9	6	1– 4	3	2– 3	2	4– 7	5
Do	5	1– 1	1	1– 1	1	1– 1	1	1– 1	1	1– 1	1
Abdominal segment VII	*B*	3– 7	4	6– 9	7	4– 8	6	2– 3	3	6–10	10
Do	*C*	2– 3	3	1– 4	3	1– 5	3	1– 1	1	2– 4	3
Do	1	1– 5	2	2– 3	3	1– 3	1	1– 1	1	3– 4	3
Do	2	1– 4	2	1– 3	2	1– 3	1	2– 2	2	2– 3	3
Do	3	2– 4	3	3– 5	3	1– 6	3	2– 3	3	3– 6	4
Do	4	3– 6	5	4– 7	5	1– 4	2	1– 2	2	4– 8	6
Do	5	1– 1	1	1– 1	1	1– 1	1	1– 1	1	1– 1	1
Abdominal segment VIII	*A*	6–19	14	10–19	14	7–16	11	10–14	11	8–10	8
Do	*A'*	1– 4	3	2– 5	3	1– 4	3	2– 3	3	3– 4	4
Do	5	1– 1	1	1– 1	1	1– 1	1	1– 1	1	1– 1	1
Paddle	*p*	1– 1	1	1– 1	1	1– 1	1	1– 1	1	1– 1	1
Do	*ap*	3– 5	4	4– 7	5	2– 5	3	1– 2	2	2– 4	3

TABLE 1.—*Variation in the branching of pupal hairs in the subgenus Myzomyia*—Continued.

Part.	Hairs.	Group *Pseudomyzomyia*.											
		Anopheles indefinitus.				*Anopheles limosus*.		*Anopheles litoralis*.		*Anopheles ludlowi*.		*Anopheles parangensis*.	
		Fresh water.		Salt water.									
		Range.	Usual.	Range.	Usual.	Range.	Usual.	Range.	Usual.	Range.	Usual.	Range.	Usual.
Metathorax	*R*	2- 4	3	2- 3	3	2- 5	3	1- 3	2	1- 3	3	5- 8	7
Do	*P*	3- 5	3	2- 4	3	2- 5	3	3- 4	3	2- 4	3	3- 5	3
Do	*O*	1- 4	2	2- 5	3	2- 3	2	1- 6	3	1- 4	2	2- 4	2
Abdominal segment I	*H*	1- 4	2	1- 2	1	1- 2	1	1- 2	1	1- 2	1	1- 1	1
Do	*K*	4- 8	5	4- 7	5	3- 5	5	3- 7	4	3- 5	4	5- 9	7
Do	*L*	5–10	9	6- 9	7	5- 8	6	5- 8	6	5- 7	6	7–12	8
Do	*M*	1- 3	2	1- 2	2	3- 3	3	1- 3	2	1- 3	2	1- 1	1
Do	*S*	3- 8	6	3- 8	5	4- 7	5	2- 6	3	3- 6	5	6–10	8
Do	*T*	1- 1	1	1- 1	1	1- 1	1	1- 2	1	1- 2	2	1- 2	1
Do	*U*	1- 1	1	1- 1	1	1- 1	1	1- 2	1	1- 2	1	1- 1	1
Abdominal segment II	*C*	5- 9	7	4- 9	7	5- 7	7	3- 6	4	4- 8	6	7–10	9
Do	1	1- 1	1	1- 1	1	1- 1	1	1- 3	1	1- 3	2	1- 1	1
Do	1	4- 8	5	3- 7	4	5- 7	5	3- 6	4	4- 9	4	5- 8	6
Do	2	3- 6	5	3- 5	4	3- 5	4	1- 2	2	2- 4	3	4- 6	5
Do	2	4- 7	5	4- 6	5	5- 7	6	4- 7	5	4- 7	6	4- 7	5
Do	3	1- 4	3	2- 3	2	2- 4	3	1- 3	1	1- 5	3	3- 6	5
Do	4	5–12	7	5- 9	7	4- 7	6	3- 6	5	5- 8	5	5- 6	6
Do	5	1- 1	1	1- 1	1	1- 2	1	1- 1	1	1- 1	1	1- 1	1
Abdominal segment III	*B*	5- 8	6	4- 8	5	5- 7	7	3- 8	5	4- 9	5	5–11	8
Do	*C*	4- 7	5	3- 6	4	5- 8	6	2- 5	3	3- 7	4	5–11	9
Do	1	3- 7	5	3- 6	3	2- 3	2	1- 3	2	2- 3	2	3- 5	3
Do	2	4- 9	6	5- 9	6	4- 6	5	5- 8	6	4- 8	6	4- 7	5
Do	3	2- 4	3	1- 3	3	1- 3	3	2- 4	3	1- 4	3	2- 6	4
Do	4	5- 8	7	4- 8	7	5- 8	7	3- 5	4	3- 7	4	5- 7	6
Do	5	1- 1	1	1- 1	1	1- 1	1	1- 1	1	1- 2	1	1- 1	1

Abdominal segment IV	*B*	3–7	5	3–6	5	3–6	5	3–7	5	3–6	5	5–8	7
Do	*C*	3–6	4	3–5	4	3–5	3	1–3	1	1–2	1	6–10	7
Do	1	2–5	3	3–4	3	1–3	2	1–2	1	1–1	1	3–5	4
Do	2	3–8	5	4–8	6	4–6	4	4–7	6	3–7	5	3–6	6
Do	3	4–7	6	4–6	5	5–7	6	4–7	5	3–7	5	5–8	7
Do	4	4–7	5	3–7	6	3–5	4	2–5	3	2–4	3	5–7	6
Do	5	1–1	1	1–1	1	1–1	1	1–1	1	1–1	1	1–1	1
Abdominal segment V	*B*	3–5	4	3–5	3	4–5	5	1–6	4	3–5	4	4–5	5
Do	*C*	1–1	1	1–2	1	1–2	1	1–2	1	1–1	1	1–1	1
Do	1	2–5	3	2–3	3	2–3	2	1–1	1	1–1	1	3–5	4
Do	2	3–6	4	2–6	4	3–5	4	3–5	3	3–6	5	4–5	5
Do	3	1–3	2	1–3	2	1–4	3	1–3	1	1–3	2	1–4	3
Do	4	3–7	5	3–5	4	3–5	4	1–4	3	3–4	3	4–7	6
Do	5	1–1	1	1–1	1	1–1	1	1–1	1	1–1	1	1–2	1
Abdominal segment VI	*B*	3–5	3	3–5	3	3–6	5	2–5	3	3–6	4	3–5	4
Do	*C*	1–1	1	1–1	1	1–2	1	1–1	1	1–1	1	1–1	1
Do	*C'*	2–4	3	1–4	3	1–3	2	1–3	2	1–4	2	2–3	3
Do	1	2–4	3	2–3	2	2–3	2	1–1	1	1–2	1	3–5	4
Do	2	1–3	2	2–3	2	1–2	2	1–1	1	1–2	1	1–4	3
Do	4	3–6	5	3–5	4	3–5	3	1–3	2	2–3	3	4–6	5
Do	5	1–1	1	1–1	1	1–1	1	1–1	1	1–2	1	1–1	1
Abdominal segment VII	*B*	2–4	3	2–5	3	4–5	5	2–6	3	3–5	4	2–5	3
Do	*C*	1–1	1	1–1	1	1–1	1	1–1	1	1–1	1	1–1	1
Do	1	2–4	3	2–4	2	2–3	2	1–3	2	1–3	1	1–4	3
Do	2	1–3	1	1–2	1	1–2	1	1–2	1	1–2	1	2–3	3
Do	3	2–5	4	3–5	3	3–4	3	2–4	3	2–4	3	1–5	4
Do	4	3–6	4	3–4	4	3–5	4	1–3	2	1–5	3	4–7	4
Do	5	1–1	1	1–1	1	1–1	1	1–1	1	1–2	1	1–1	1
Abdominal segment VIII	*A*	9–18	11	8–16	12	11–22	14	9–16	11	7–16	12		10
Do	*A'*	1–3	2	1–2	1	1–2	2	1–1	1	1–2	1	3–3	3
Do	5	1–1	1	1–1	1	1–1	1	1–1	1	1–1	1	1–1	1
Paddle	*p*	1–1	1	1–1	1	1–1	1	1–1	1	1–1	1	1–1	1
Do	*ap*	2–4	3	2–3	3	1–2	2	1–3	2	2–3	2	3–5	5

TABLE 2.—*Lengths of pupal spines in species of the subgenus Myzomyia.*

[Figures are fractions of a millimeter.]

Group and species.	A-II			A-III			A-IV		
	Range.	Average.	Commonest.	Range.	Average.	Commonest.	Range.	Average.	Commonest.
Myzomyia									
Anopheles filipinæ	0.0334–0.0668	0.0526	0.0501	0.0668–0.1837	0.0980	0.0835	0.2505–0.5010	0.3976	0.3674
Anopheles minimus var. *flavirostris*	0.0501–0.0668	0.0626	0.0501	0.0668–0.1002	0.0935	0.0835	0.3507–0.4509	0.3974	0.4008
Anopheles mangyanus	0.0251–0.0835	0.0566	0.0668	0.1169–0.2672	0.1697	0.1336	0.5016–0.6847	0.6273	0.6179
Neocellia									
Anopheles annularis	0.0251–0.1002	0.0361	0.0334	0.0919–0.1670	0.1274	0.1336	0.1837–0.4008	0.2573	0.2338
Anopheles philippinensis	0.0334–0.0668	0.0439	0.0334	0.1062–0.1670	0.1258	0.1169	0.1670–0.3173	0.2041	0.1837
Anopheles karwari	0.0418–0.0501	0.0486	0.0501	0.0501–0.0835	0.0703	0.0668	0.0668–0.1336	0.0930	0.1002
Anopheles maculatus	0.0334–0.0835	0.0351	0.0334	0.0418–0.1062	0.0668	0.0585	0.2338–0.3517	0.3022	0.3340
Neomyzomyia									
Anopheles leucosphyrus	0.0251–0.0334	0.0317	0.0334	0.0334–0.0501	0.0443	0.0501	0.0501–0.1002	0.0718	0.0668
Anopheles l. var. *balabacensis*	0.0167–0.0668	0.0428	0.0501	0.0501–0.1002	0.0735	0.0668	0.1670–0.3340	0.2801	0.3006
Anopheles cristatus	0.0334–0.0501	0.0362	0.0334	0.0334–0.0835	0.0585	0.0668	0.0501–0.0919	0.0723	0.0835
Anopheles kochi	0.0334–0.0418	0.0384	0.0334	0.0334–0.0501	0.0397	0.0334	0.0501–0.0668	0.0585	0.0585
Anopheles tessellatus	0.0251–0.0501	0.0334	0.0334	0.0334–0.0668	0.0501	0.0501	0.0334–0.0835	0.0668	0.0668
Pseudomyzomyia									
Anopheles indefinitus, fresh water	0.0334–0.0918	0.0676	0.0668	0.1002–0.1837	0.1299	0.1336	0.1837–0.3340	0.2725	0.3173
Anopheles indefinitus, salt water	0.0334–0.0835	0.0548	0.0668	0.0835–0.2004	0.1271	0.1002	0.1169–0.2839	0.2098	0.2171
Anopheles limosus	0.0334–0.0501	0.0478	0.0501	0.0668–0.1169	0.0997	0.1002	0.1086–0.2004	0.1560	0.1336
Anopheles litoralis	0.0251–0.0501	0.0423	0.0501	0.0668–0.1169	0.0969	0.1002	0.1002–0.2505	0.1823	0.2004
Anopheles ludlowi	0.0251–0.0835	0.0631	0.0501	0.0835–0.2004	0.1481	0.1503	0.2338–0.4676	0.3186	0.3173
Anopheles parangensis	0.0334–0.0585	0.0434	0.0501	0.1002–0.1169	0.1119	0.1169	0.1670–0.2171	0.1962	0.2004

Group and species.	A-V			A-VI			A-VII		
	Range.	Average.	Commonest.	Range.	Average.	Commonest.	Range.	Average.	Commonest.
Myzomyia									
Anopheles filyinæ	0.3841–0.6179	0.5115	0.4843	0.5344–0.7849	0.6563	0.6179	0.5511–0.8016	0.6982	0.6847
Anopheles minimus var. *flavirostris*	0.5177–0.6513	0.5855	0.6012	0.5845–0.7682	0.6735	0.6680	0.6680–0.8183	0.7627	0.7575
Anopheles mangyanus	0.5845–0.8183	0.7047	0.7181	0.7014–0.9352	0.8165	0.8183	0.7014–0.9686	0.8579	0.8360
Neocellia									
Anopheles annularis	0.3340–0.5845	0.4399	0.4509	0.4008–0.6346	0.5165	0.5010	0.5010–0.6847	0.5716	0.5678
Anopheles philippinensis	0.4342–0.7515	0.5237	0.5177	0.5177–0.8547	0.6398	0.6346	0.6680–0.8851	0.7675	0.7682
Anopheles karwari	0.3841–0.7847	0.5384	0.5344	0.4843–0.7515	0.6099	0.5845	0.5177–0.7849	0.6480	0.6346
Anopheles maculatus	0.5678–0.6346	0.6075	0.6179	0.6179–0.7181	0.6530	0.6346	0.6513–0.7515	0.7036	0.7181
Neomyzomyia									
Anopheles leucosphyrus	0.2004–0.2672	0.2238	0.2171	0.2338–0.3340	0.2889	0.2339	0.3006–0.3674	0.3273	0.3170
Anopheles l. var. *balabacensis*	0.3340–0.4175	0.3724	0.3841	0.3674–0.4342	0.3904	0.3674	0.3170–0.4509	0.3818	0.3841
Anopheles cristatus	0.3173–0.4927	0.4315	0.4175	0.3841–0.5594	0.4700	0.4674	0.3841–0.5177	0.4342	0.4008
Anopheles kochi	0.1086–0.1336	0.1189	0.1169	0.2004–0.2338	0.2008	0.2004	0.2756–0.3006	0.2839	0.2839
Anopheles leaellatus	0.0668–0.1336	0.1086	0.1169	0.1002–0.1503	0.1281	0.1336	0.1587–0.2255	0.1795	0.1670
Pseudomyzomyia									
Anopheles indefinitus, fresh water	0.5511–0.8851	0.7313	0 7515	0.7181–1.0020	0.8655	0.9185	0.7348–1.1189	0.9223	0.9185
Anopheles indefinitus, salt water	0.5344–0.9185	0.7757	0.7515	0.6847–1.0354	0.8704	0.8684	0.7849–1.0521	0.9297	0.9018
Anopheles limosus	0.5344–0.8016	0.6501	0.6513	0.7849–1.0855	0.9507	0.9519	1.0187–1.2859	1.1511	1.1189
Anopheles litoralis	0.5845–1.0354	0.8393	0.8851	0.8183–1.2525	0.9965	1.0354	0.8684–1.2024	1.0633	1.1189
Anopheles ludlowi	0.5344–0.9018	0.7310	0.7849	0.6847–1.0020	0.8903	0.8517	0.8351–1.1022	1.0080	1.0187
Anopheles parangensis	0.5845–0.7515	0.6805	0.6847	0.6012–0.8350	0.7460	0.7515	0.8684–1.0020	0.9143	0.9185

Curiously, *cristatus,* which is different in the larval stage from the other species of the group, does not, in the pupal stage, possess any peculiarity that will readily segregate it from the rest. On the contrary, var. *balabacensis* whose larva is very much like that of *leucosphyrus* can easily be recognized in the pupal stage, for its relatively long spines, particularly those on segment IV. By average values *A*–IV of var. *balabacensis* is about four times as long as the corresponding spine of the other species. Except in *tessellatus,* branchings of the spines are usually found at least on *A*–VII. Branchings on *A*–V to *A*–VII are usually present in var. *balabacensis, cristatus,* and *kochi;* occasional branching is present also on *A*–IV of var. *balabacensis,* while sometimes *leucosphyrus* does not have any branches, even on *A*–VII. By normal occurrence and by average values, the spines of *kochi* and *tessellatus,* especially those on segments V and VI, are shorter than those of the other species under the group.

For the related *leucosphyrus* forms the reader is referred to part IV of these Notes.

Key to the species of group Neomyzomyia, based on pupal characters.

1. *A*–IV at least 0.167 mm long, usually longer. *leucosphyrus* var. *balabacensis.*
   A–IV much less than 0.167 mm long ..... 2.
2. *A*–V at least 0.2 mm long, usually much longer ..... 3.
   A–V much less than 0.2 mm long ..... 4.
3. At least *A*–VI and *A*–VII with branches ..... *cristatus.*
   Branchings of spines, if present, only on *A*–VII ..... *leucosphyrus* and probably also *leucosphyrus* var. *riparis.*
4. *C'* simple; *B*–V and *B*–VII branched 3 to 5 and 2 or 3, respectively. *kochi.*
   C' branched 5 to 8; *B*–V and *B*–VII branched 8 to 12 and 6 to 10, respectively ..... *tessellatus.*

GROUP MYZOMYIA

The three species of this group are hard to separate in the pupal stage. By average values in lengths of the spines it may be possible to differentiate *mangyanus* quite readily, but average values have very limited practical usefulness. The following key is offered merely as a general guide in differentiating the pupæ of the three species:

Key to the species of the group Myzomyia, based on pupal characters.

1. *A*–IV from 0.5 to 0.7 mm, average 0.6 mm long; *A*–III usually over twice the length of *A*–II ..... *mangyanus.*
   A–IV from 0.25 to 0.5 mm, average 0.397 mm long; *A*–III usually less than twice as long as *A*–II ..... 2.

2. *B*–III usually with less than 10 branches; *B*–VII branched around 4; *A*–III distinctly blunt ..... *filipinæ*.
B–III with at least 10 branches; *B*–VII branched around 7; *A*–III usually pointed ..... *minimus* var. *flavirostris*.

Branching of *A*–VII whenever present is by simple splitting of the spine into two, unlike that in the species of the group *Neomyzomyia* where more than one branch are usually present in each spine; the branches, however, in the group *Myzomyia* are often much longer than in the group *Neomyzomyia*. The highest percentage of branching on *A*–VII in the group *Myzomyia* is among specimens of *mangyanus*, of which 19 per cent in our series have this peculiarity.

GROUP PSEUDOMYZOMYIA

Following Morishita's opinion (1935) which was previously indicated by King (1931), *Anopheles indefinitus* is here considered specific in status instead of being a variety of *subpictus*. But whether or not the local forms of fresh- and salt-water *indefinitus* are distinct from each other is yet to be determined by studies on their eggs. Walch and Walch-Sorgdrager (1934) have shown from egg characters that fresh- and salt-water *subpictus* in Netherland India are different from each other. It can hardly be expected that differences in the two local forms of *indefinitus* could be found in the pupal stage when even distinct species under the group are very similar in this stage. Moreover, King (1931) and others have found no difference between these forms in the larval or adult stages.

The peculiar case reported by Sen (1935) of a female *Anopheles vagus*, from whose eggs larvæ and adults of both *vagus* and *subpictus* types were produced, if proved correct by further experiments, will cause drastic changes in the classification of the group, and possibly a return to the old usage of *rossi* as embracing all these allied forms. Sen's discovery will throw some doubt on the best methods of classification. However, as reported by Walch and Walch-Sorgdrager (1934) there is a big difference between the eggs of *subpictus* and of *vagus* in Netherland India (which is likely true also in the Philippines), while in India Christophers and Barraud (1931) found the eggs of these two species very much alike. It may be supposed, therefore, that the two forms are not as distinctly separated genotypically in India as they are in other places, which makes possible the occurrence of such a case as noted by Sen. Otherwise the interracial sterility of such less distinguishable forms (mor-

phologically), as certain varieties of *maculipennis* reported by de Buck, Schoute, and Swellengrebel (1934), cannot be understood, since the distinctly different forms (morphologically) *subpictus* and *vagus* are fertile.

Of the species under group *Pseudomyzomyia, A. parangensis* alone possesses fairly marked characteristics; the others are very similar in characters.

Key to the species of group Pseudomyzomyia, based on pupal characters.

1. Paddle hair two-thirds or more the length of paddle; *R*–M and *C*–IV usually 7-branched (range 5 to 8 and 6 to 10, respectively). *parangensis.*

   Paddle hair less than two-thirds (usually less than half) the length of paddle; *R*–M and *C*–IV branched less than 7 (range 1 to 5 and 1 to 6, respectively) ..... 2.

2. Hairs *T*, *U*, and external 1–II fairly stout and extending out prominently; 1–IV usually 3-branched (range 2 to 5) ..... *indefinitus.*

   Hairs, *T*, *U*, and external 1–II more slender, usually curved; 1–IV usually simple (range 1 to 3) ..... 3.

3. Accessory denticles on anterolateral border of paddle many and distinct. *ludlowi.*

   These denticles few and indistinct ..... 4.

4. 1–IV 2- or 3-branched; *C*–IV usually 3-branched (range 3 to 5). *vagus* var. *limosus.*

   1–IV simple; *C*–IV usually simple ..... *litoralis.*

GROUP NEOCELLIA

The group *Neocellia* is included in part V of these Notes.

SUMMARY AND CONCLUSIONS

1. Pupal characters of the species of the subgenus *Myzomyia* are presented.

2. It is shown that the groups can be readily separated, but the species under certain groups are very much alike and can hardly be differentiated from one another; the keys for such groups are given merely as general guides.

3. It is indicated that probably the best method of classifying Philippine species of *Anopheles* is by a combination of the characters in all stages; such as those found in the eggs, larvæ, pupæ, and adults. It is also indicated that probably the Indian forms of *subpictus* and *vagus* are not identical with *subpictus* and *vagus* of Netherland India, and the Philippines; those of India are apparently more closely related than those of other places, which makes possible the peculiar case reported by Sen. If this is correct, crosses between *indefinitus* and *vagus* var.

limosus in the Philippines probably do not take place, or if they do the resulting eggs or imagines are very likely sterile.

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ILLUSTRATIONS

[The illustrations were drawn with the aid of a camera lucida; the respiratory trumpets from unmounted specimens; all the others from flat preparations.]

PLATE 1. ANOPHELES FILIPINÆ MANALANG

Parts of metathorax and abdominal segments I, II, and VI. Designation of parts, hairs, and spines applies to corresponding parts, hairs, and spines of other illustrations. *R*, *P*, and *O*, hairs of metathorax. *H*, *K*, *L*, *M*, *S*, *T*, and *U*, hairs of abdominal segment I; *t* is the base of dendritic tuft. *A*, spine; *C*, large dorsal hair of abdominal segment II; 1–1, 2–2, 3, 4, and 5, other dorsal hairs of abdominal segment II. *A*, spine; *B*, *C*, and *C'*, large dorsal hairs of abdominal segment VI; 1, 2, 4, and 5, other dorsal hairs of abdominal segment VI.

PLATE 2. ANOPHELES FILIPINÆ MANALANG

FIG. 1. Respiratory trumpet.
2. Paddle and part of abdominal segment VIII. Designation of parts, hairs, and spine applies to corresponding parts, hairs, and spine of other illustrations. *A*, spine; *A'*, accessory hair of spine; 5, dorsal hair of abdominal segment VIII. *e*, external border of paddle; other parts of paddle as labeled.

PLATES 3 AND 4. ANOPHELES MINIMUS VAR. FLAVIROSTRIS LUDLOW

PLATES 5 AND 6. ANOPHELES MANGYANUS BANKS

PLATE 7. PUPAL SPINES III TO VII

FIG. 1. *Anopheles minimus* var. *flavirostris* Ludlow.
2. *Anopheles filipinæ* Manalang.
3. *Anopheles mangyanus* Banks.

PLATES 8 AND 9. ANOPHELES INDEFINITUS LUDLOW

PLATES 10 AND 11. ANOPHELES VAGUS VAR. LIMOSUS KING

PLATES 12 AND 13. ANOPHELES LITORALIS KING

PLATES 14 AND 15. ANOPHELES LUDLOWI THEOBALD

PLATES 16 AND 17. ANOPHELES PARANGENSIS LUDLOW

PLATE 18. PUPAL SPINES III TO V

FIG. 1. *Anopheles ludlowi* Theobald.
2. *Anopheles litoralis* King.
3. *Anopheles parangensis* Ludlow.
4. *Anopheles vagus* var. *limosus* King.
5. *Anopheles indefinitus* Ludlow.

PLATES 19 AND 20. ANOPHELES KOCHI DÖNITZ

PLATES 21 AND 22. ANOPHELES TESSELLATUS THEOBALD

PLATE 23. PUPAL SPINES IV TO VII

FIG. 1. *Anopheles leucosphyrus* var. *balabacensis* Baisas.
2. *Anopheles leucosphyrus* var. *balabacensis* Baisas, showing much longer *A*–IV.
3. *Anopheles kochi* Dönitz.
4. *Anopheles leucosphyrus* Dönitz.
5. *Anopheles tessellatus* Theobald.
6. *Anopheles cristatus* King and Baisas, showing unusually long *A*–IV.
7. *Anopheles cristatus* King and Baisas, showing normal *A*–IV.

PLATE 24. DUPLICATION AND SPLITTING OF PUPAL SPINES

FIG. 1. *Anopheles leucosphyrus* var. *balabacensis* Baisas.
FIGS. 2, 3, and 4. *Anopheles litoralis* King.
FIG. 5. *Anopheles vagus* var. *limosus* King.
6. *Anopheles filipinæ* Manalang.
7. *Anopheles minimus* var. *flavirostris* Ludlow.
8. *Anopheles mangyanus* Banks.

PLATE 25. DENTICLES AND ACCESSORY DENTICLES OF PADDLE

FIG. 1. *Anopheles ludlowi* Theobald; anterolateral border of paddle.
2. *Anopheles litoralis* King; anterolateral border of paddle.
FIGS. 3 and 4. *Anopheles ludlowi* Theobald.
FIG. 5. *Anopheles vagus* var. *limosus* King.
6. *Anopheles litoralis* King.
7. *Anopheles indefinitus* Ludlow.
8. *Anopheles parangensis* Ludlow.

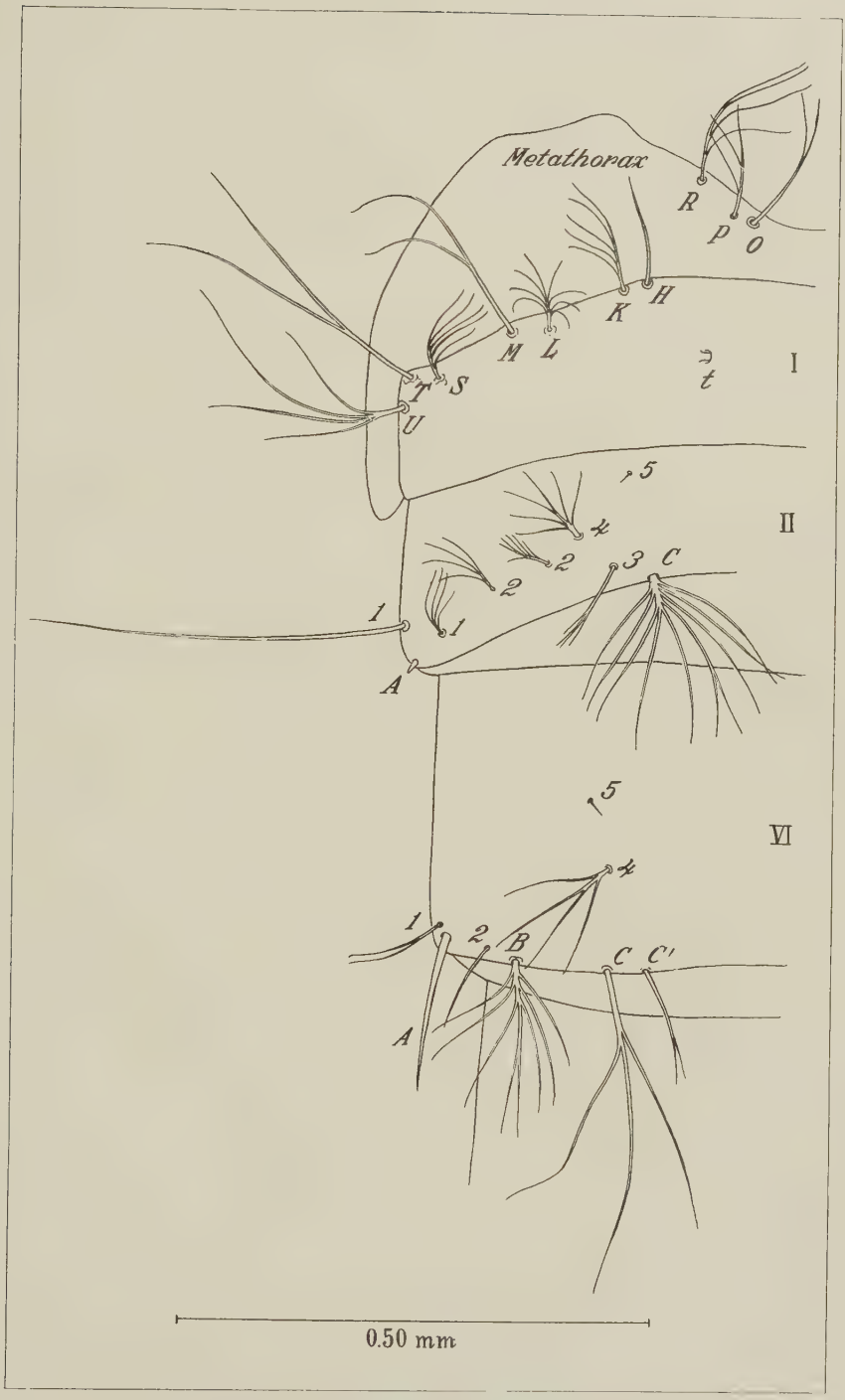

PLATE 1. ANOPHELES FILIPINÆ.

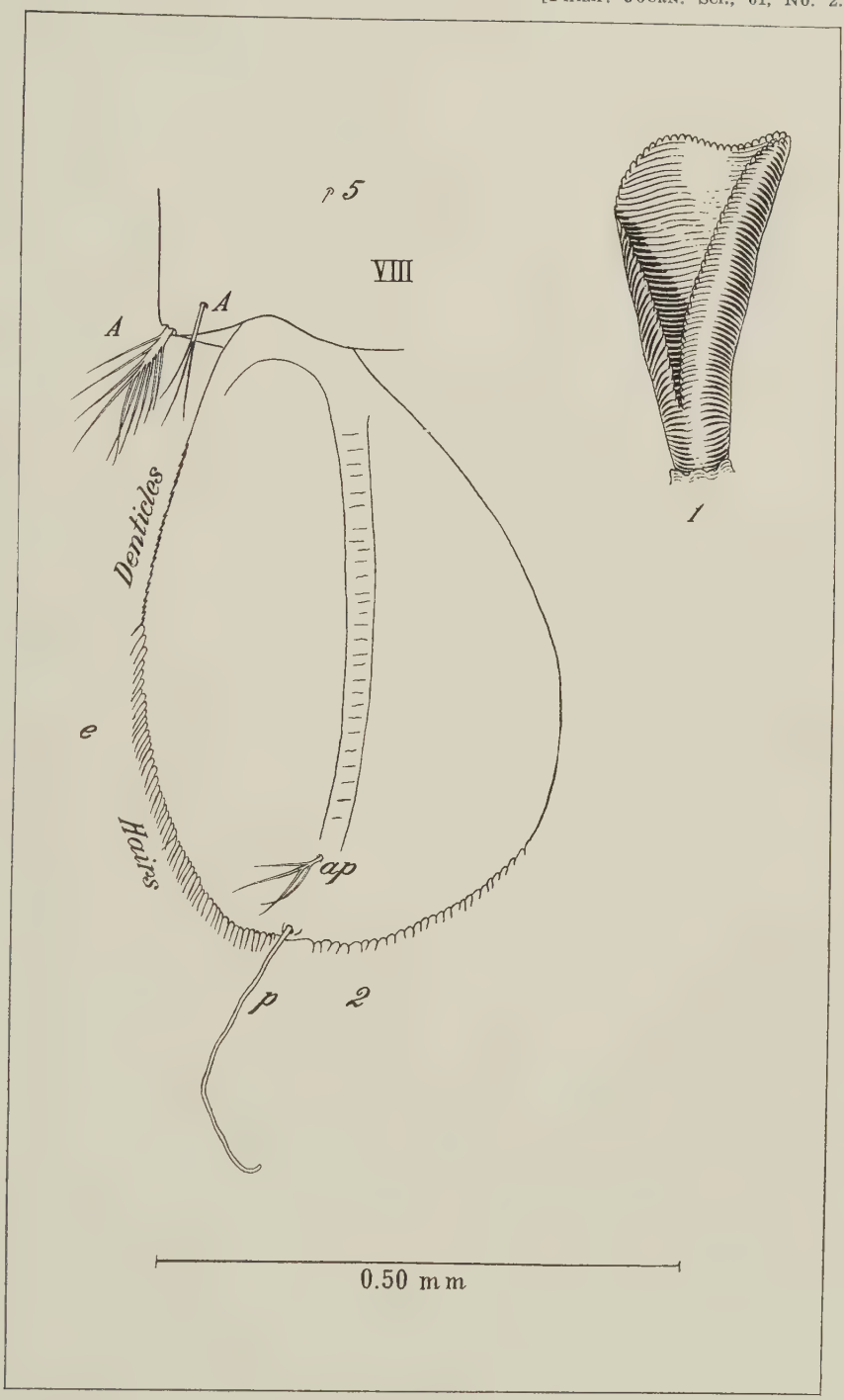

PLATE 2. ANOPHELES FILIPINÆ.

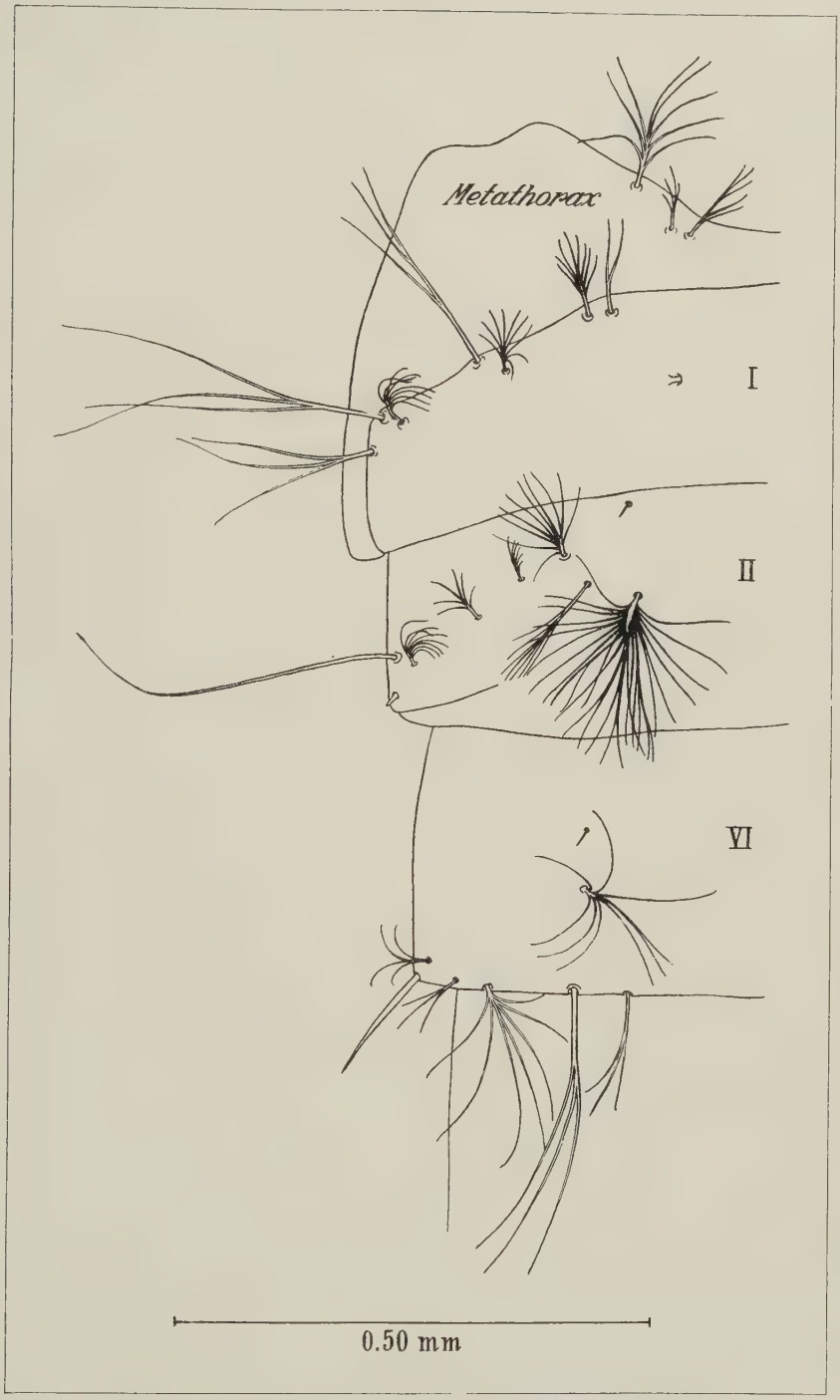

PLATE 3. ANOPHELES MINIMUS VAR. FLAVIROSTRIS.

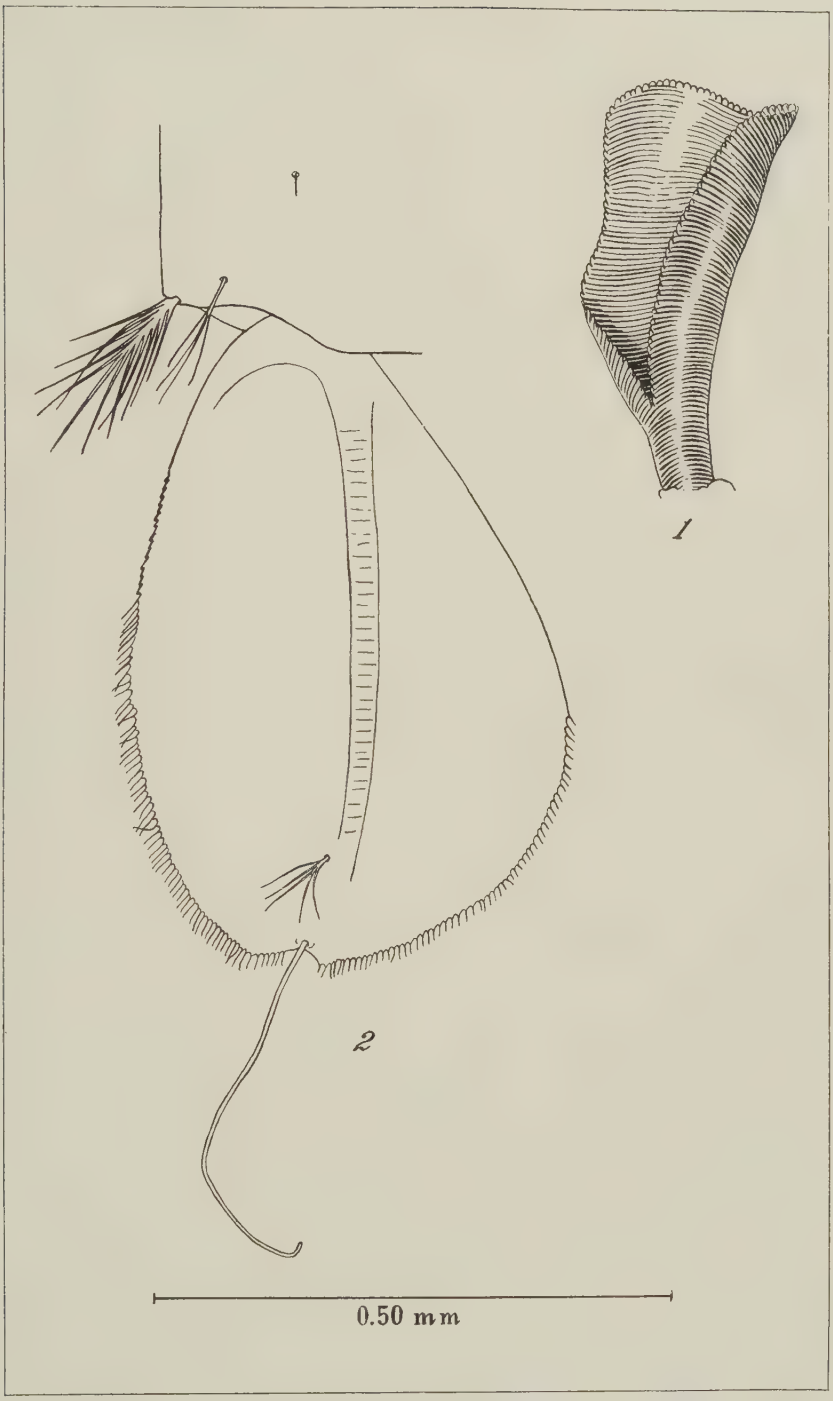

PLATE 4. ANOPHELES MINIMUS VAR. FLAVIROSTRIS.

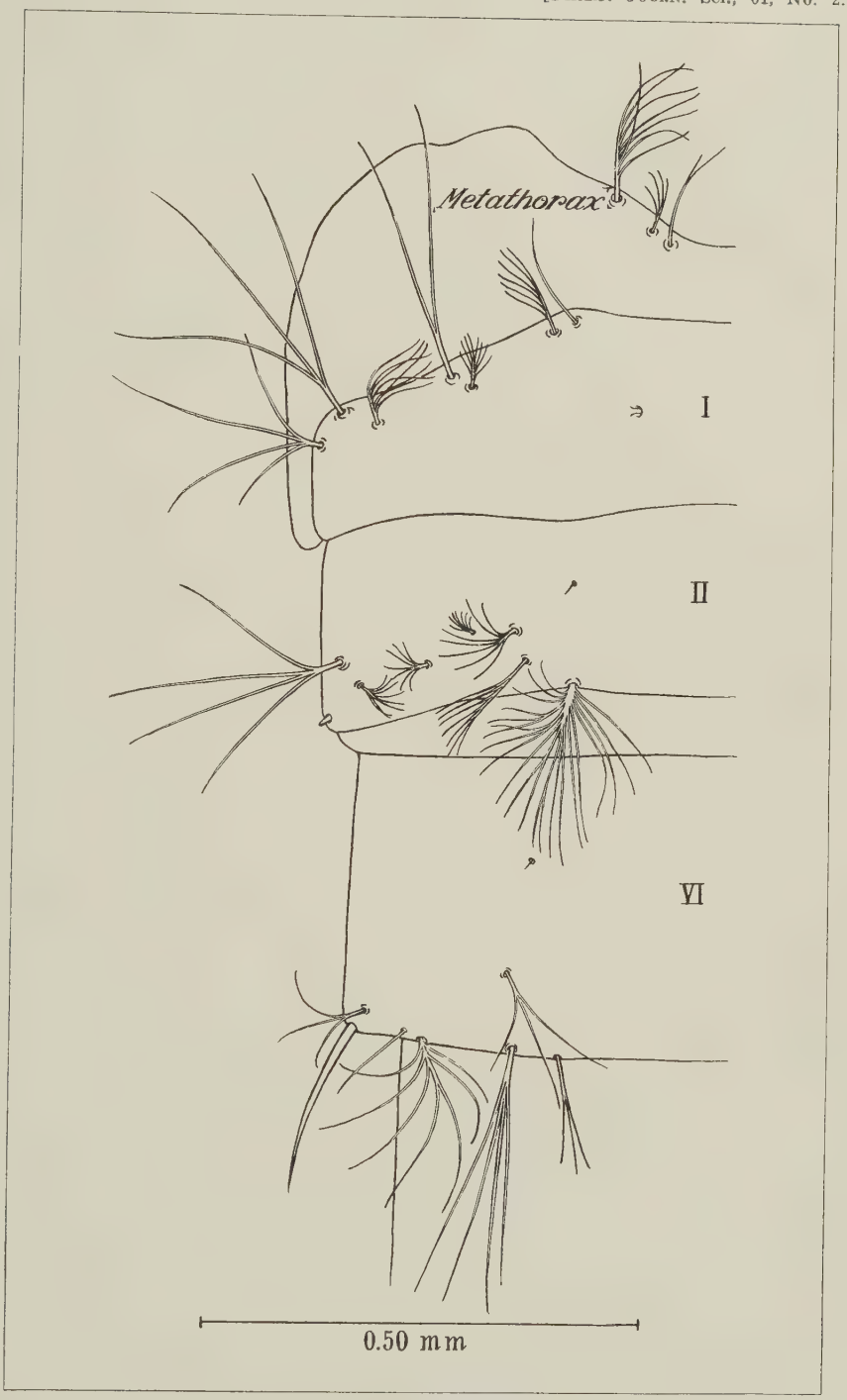

PLATE 5. ANOPHELES MANGYANUS.

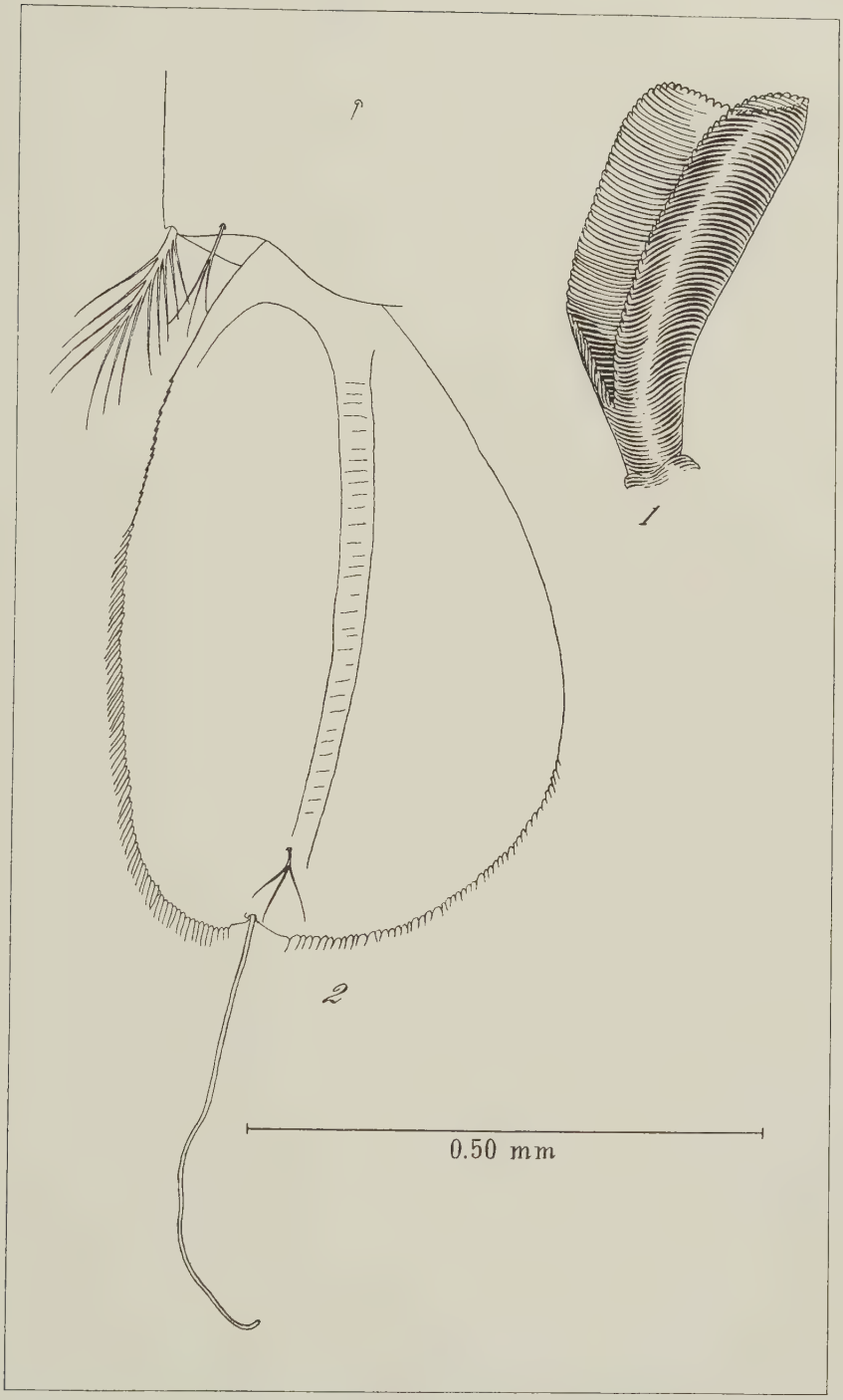

PLATE 6. ANOPHELES MANGYANUS.

PLATE 7. PUPAL SPINES III TO VII; GROUP MYZOMYIA.

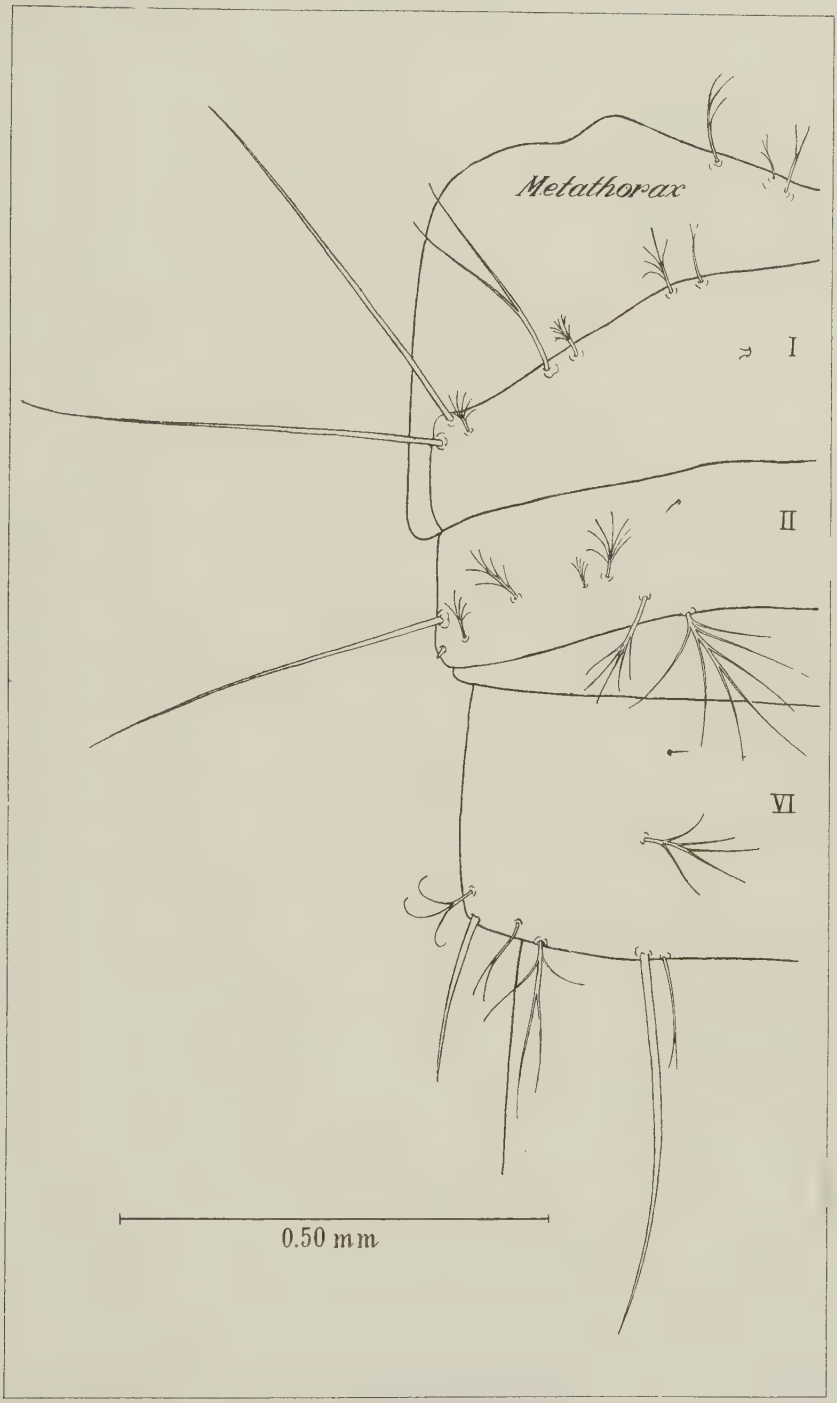

PLATE 8. ANOPHELES INDEFINITUS.

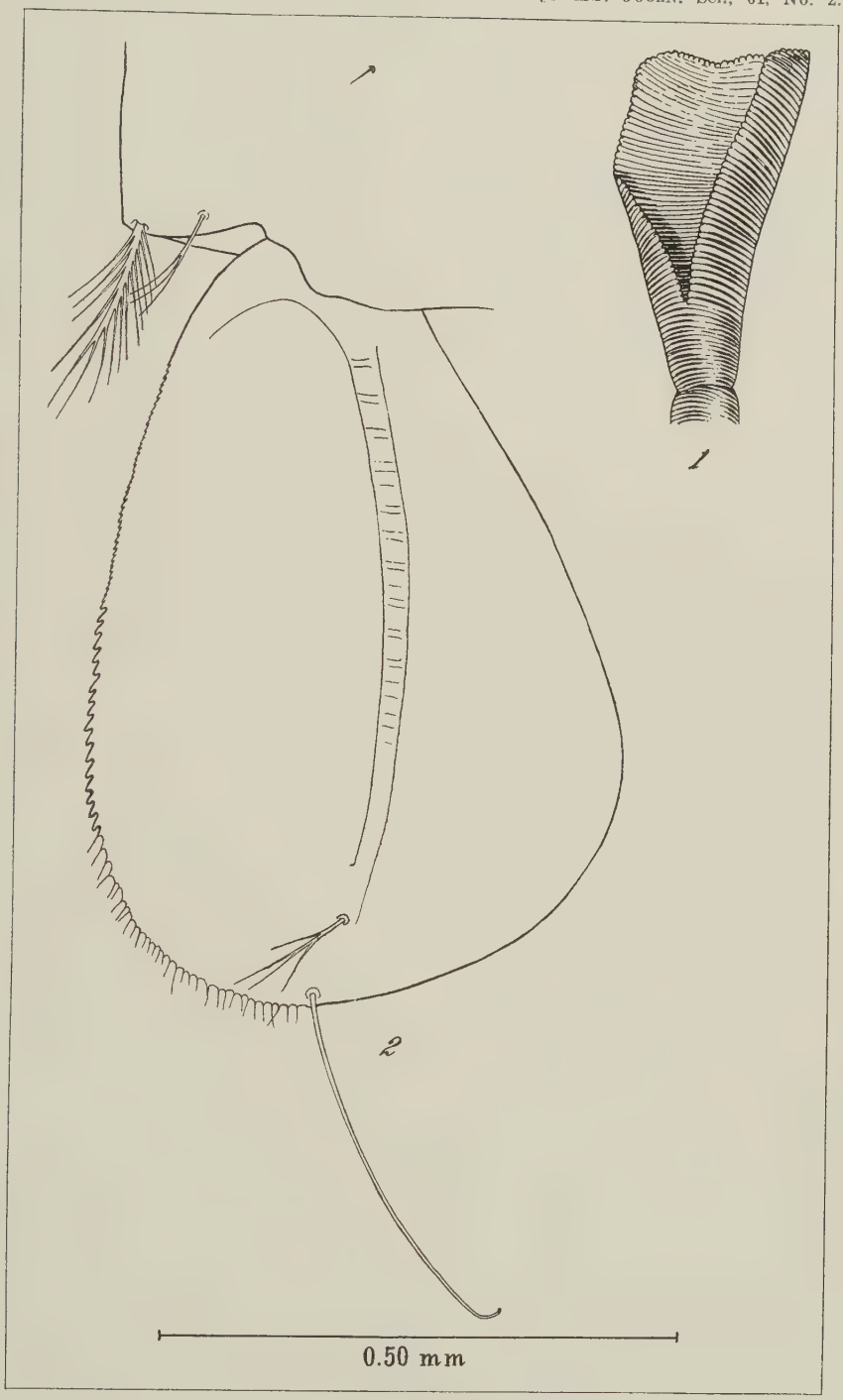

PLATE 9. ANOPHELES INDEFINITUS.

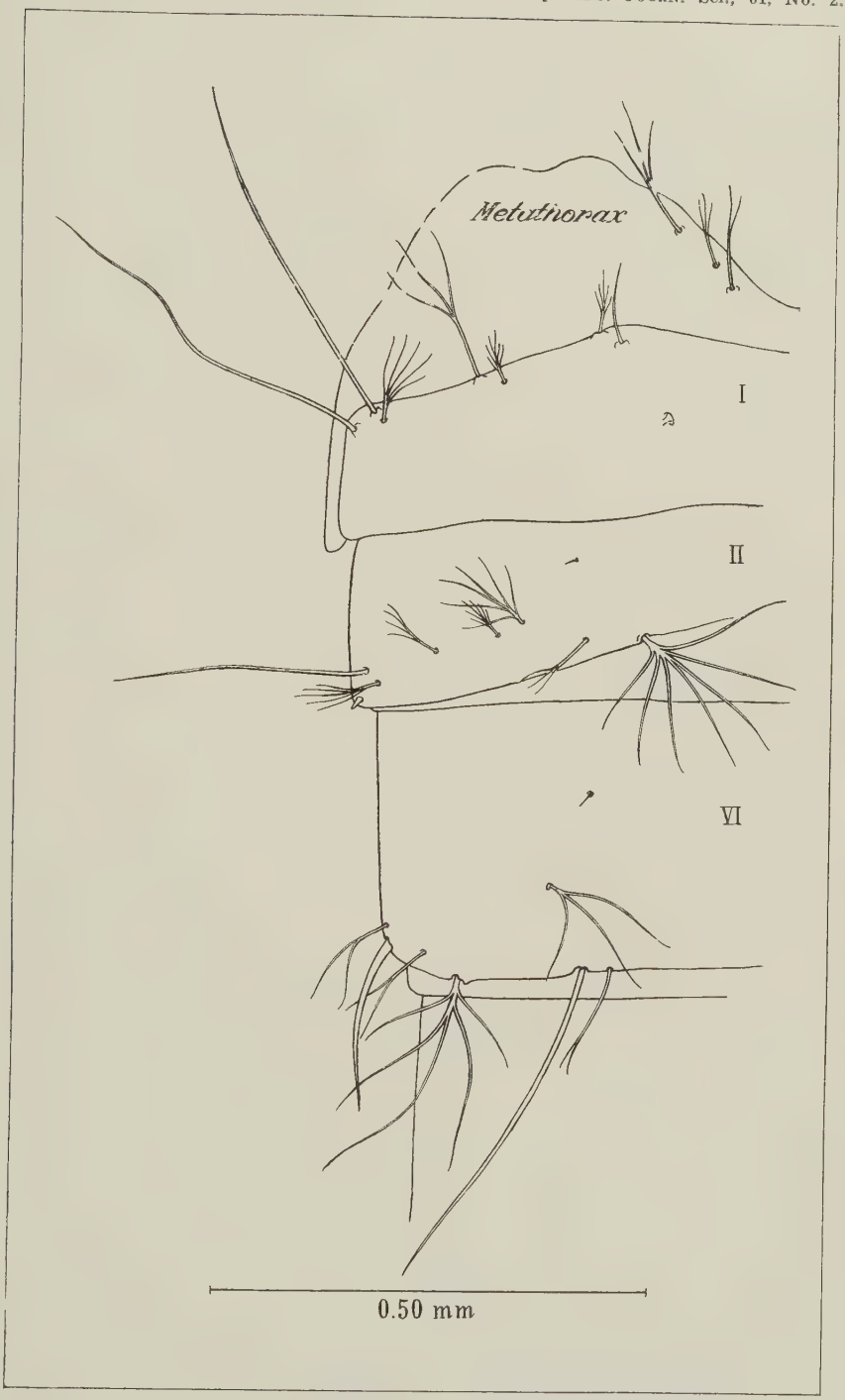

PLATE 10. ANOPHELES VAGUS VAR. LIMOSUS.

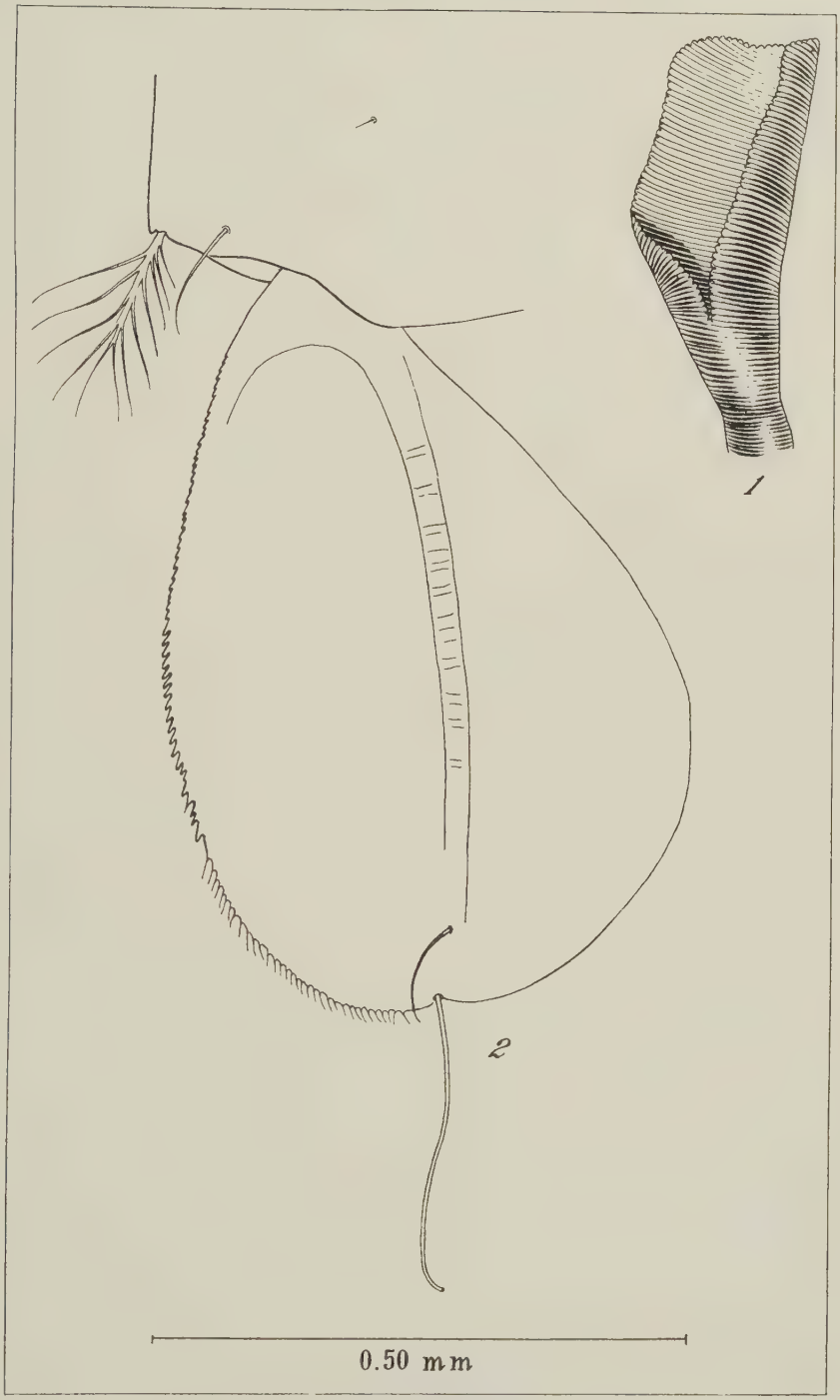

PLATE 11. ANOPHELES VAGUS VAR. LIMOSUS.

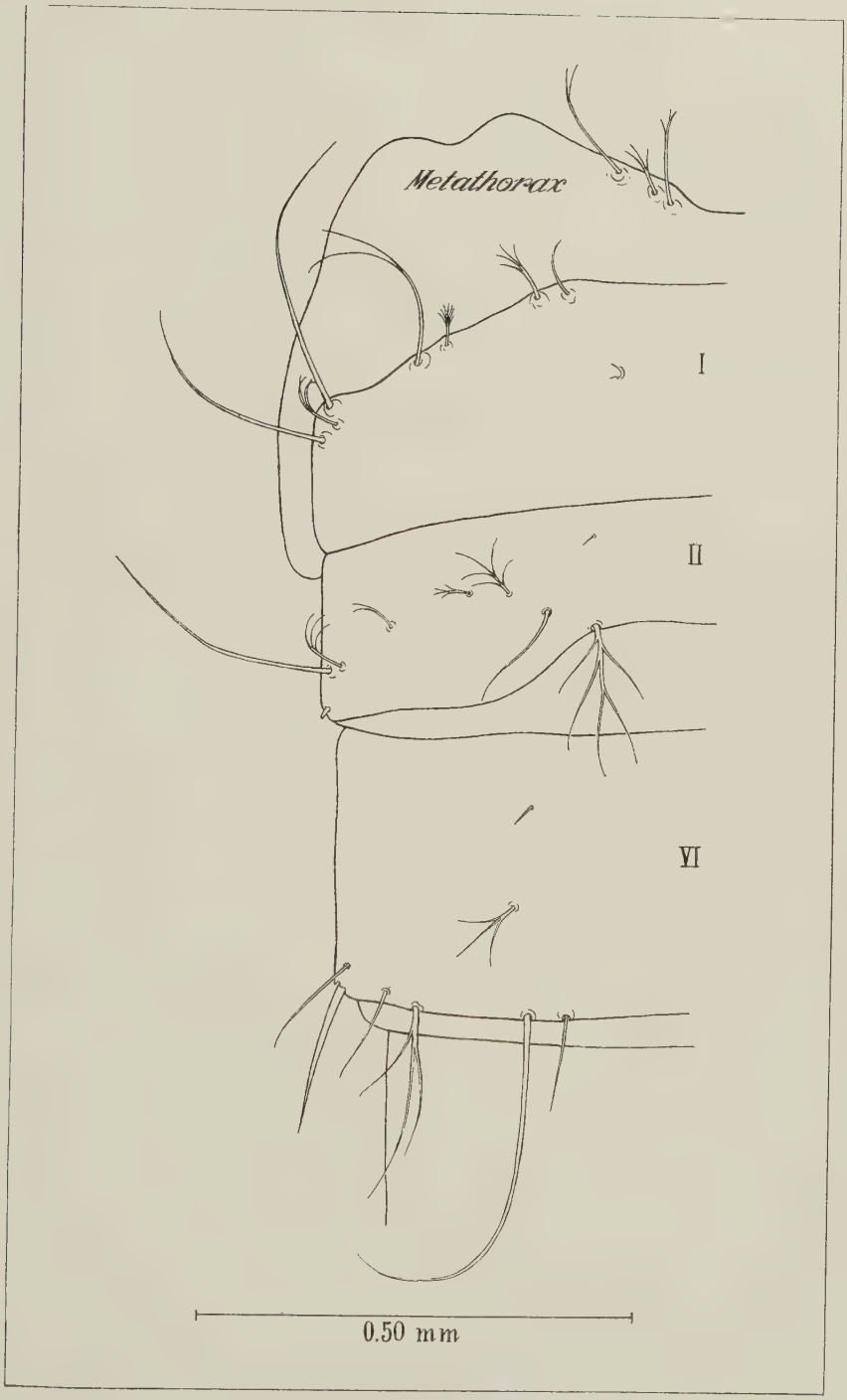

PLATE 12. AÑOPHELES LITORALIS.

PLATE 13. ANOPHELES LITORALIS.

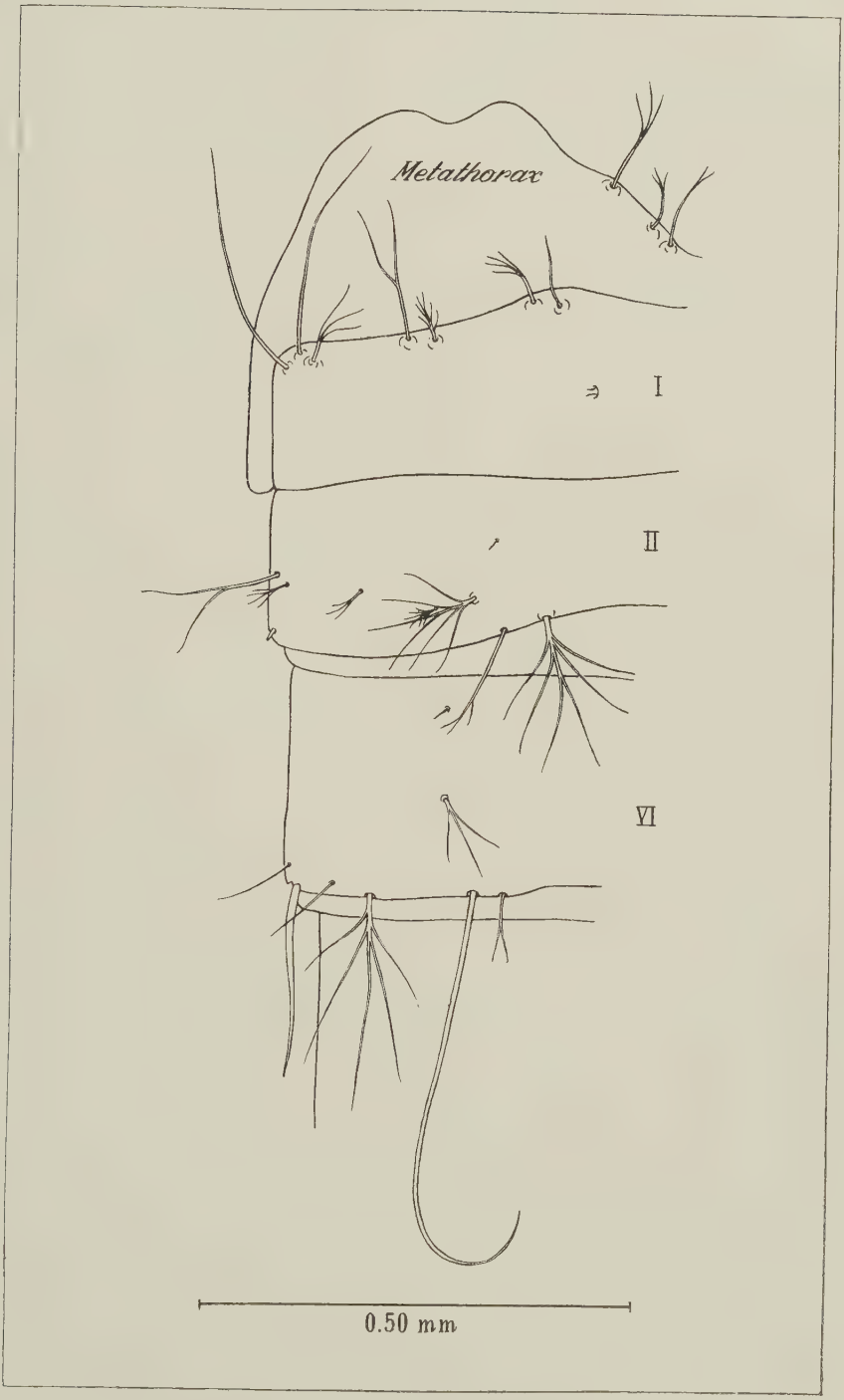

PLATE 14. ANOPHELES LUDLOWI.

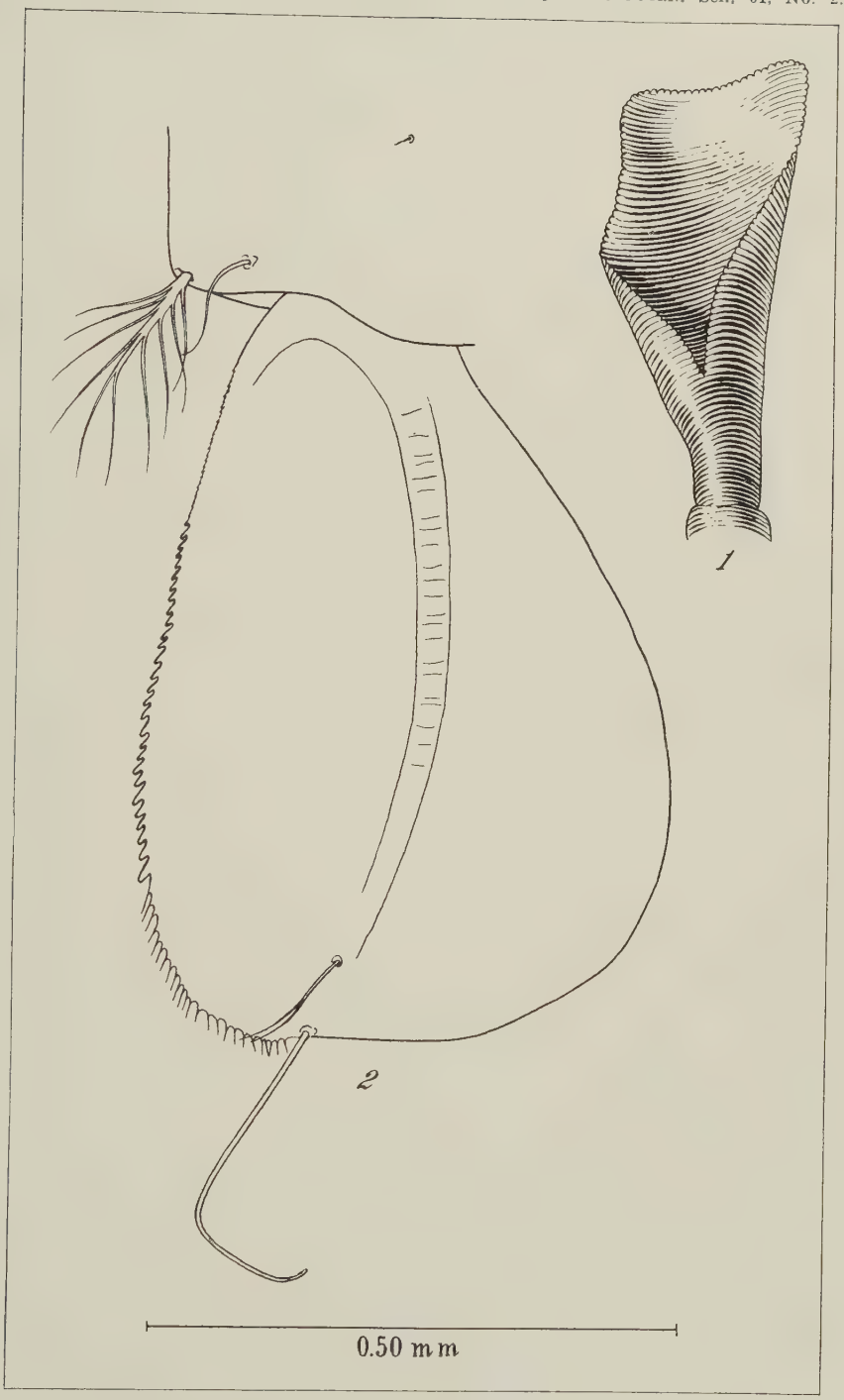

PLATE 15. ANOPHELES LUDLOWI.

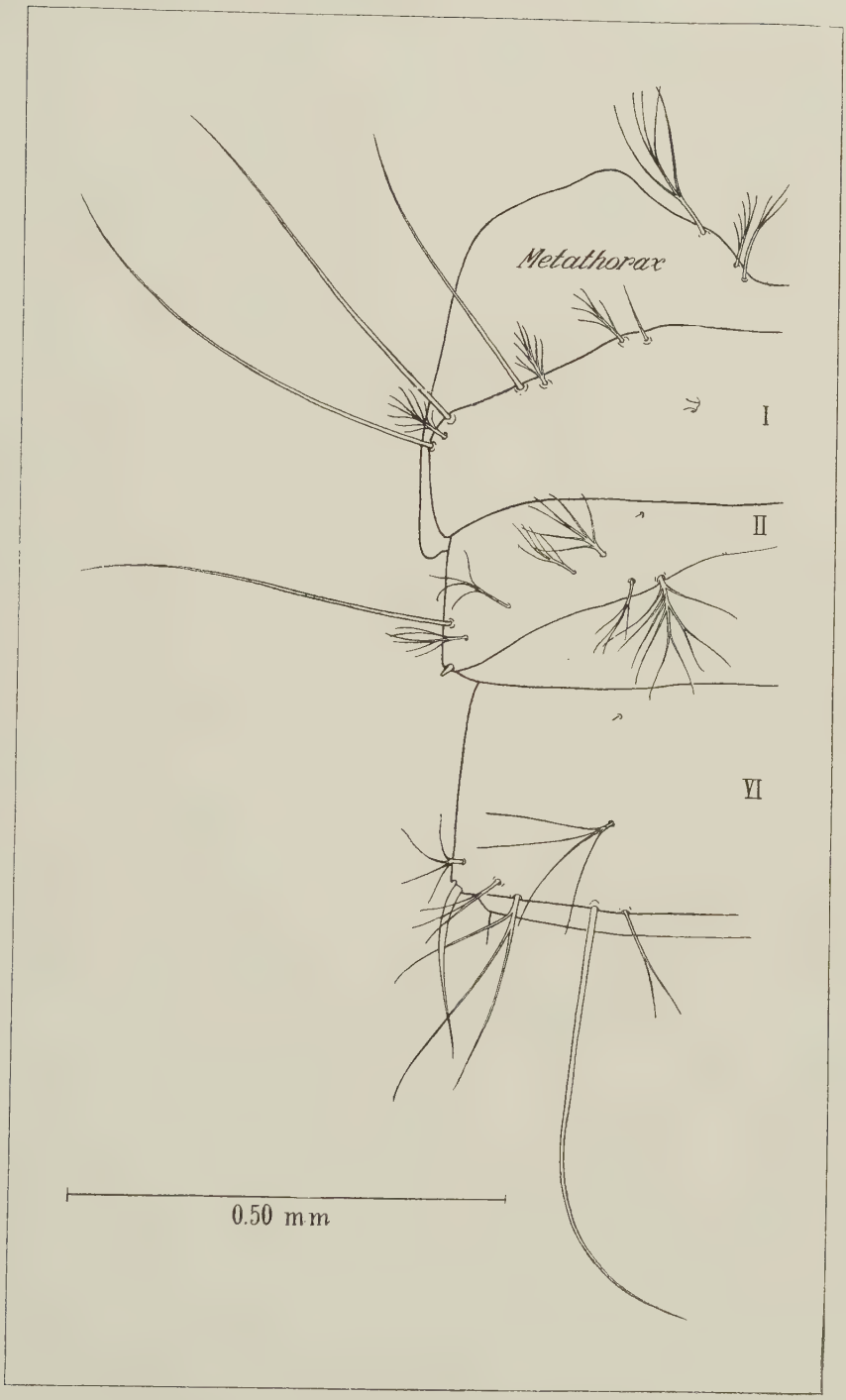

PLATE 16. ANOPHELES PARANGENSIS.

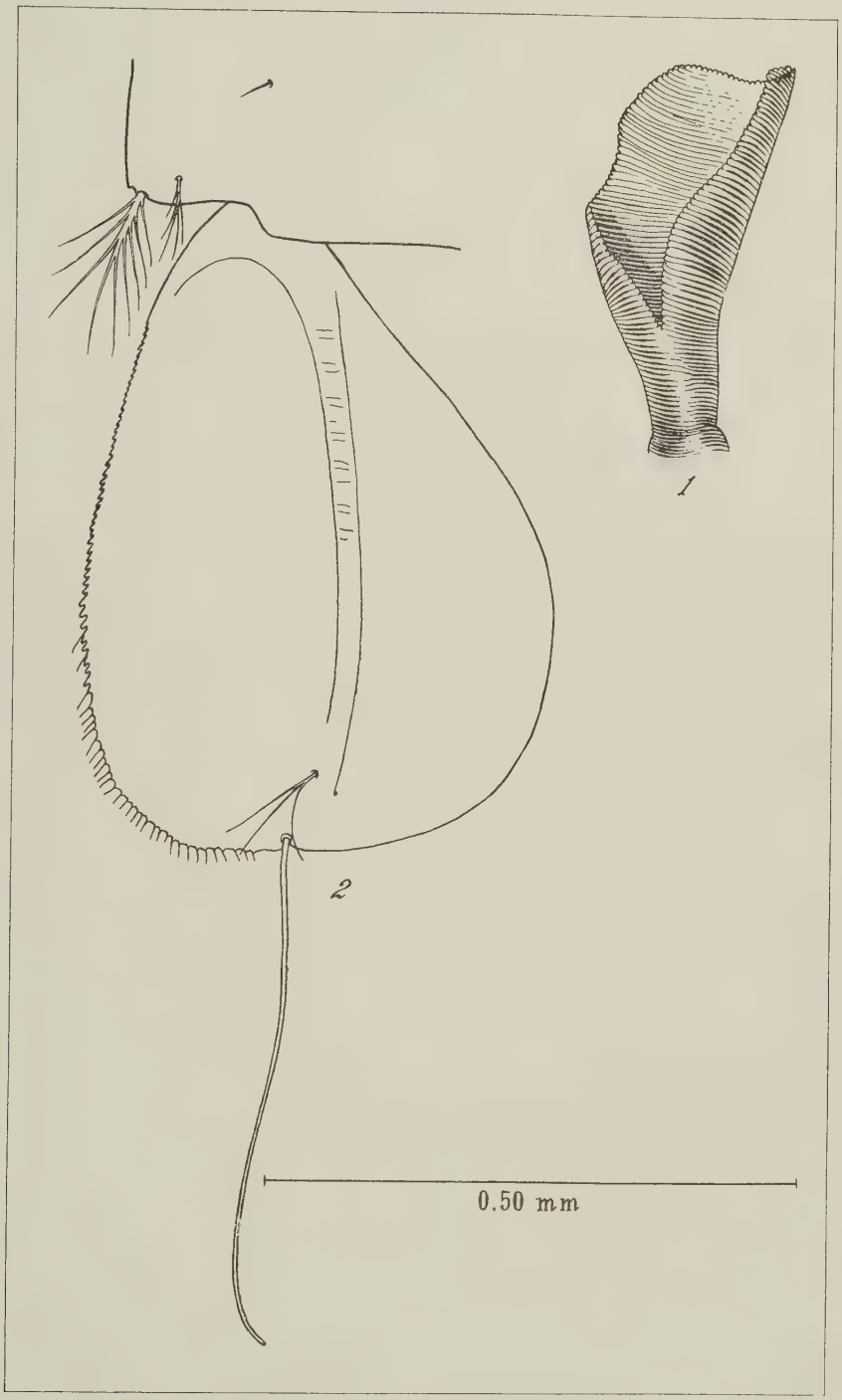

PLATE 17. ANOPHELES PARANGENSIS.

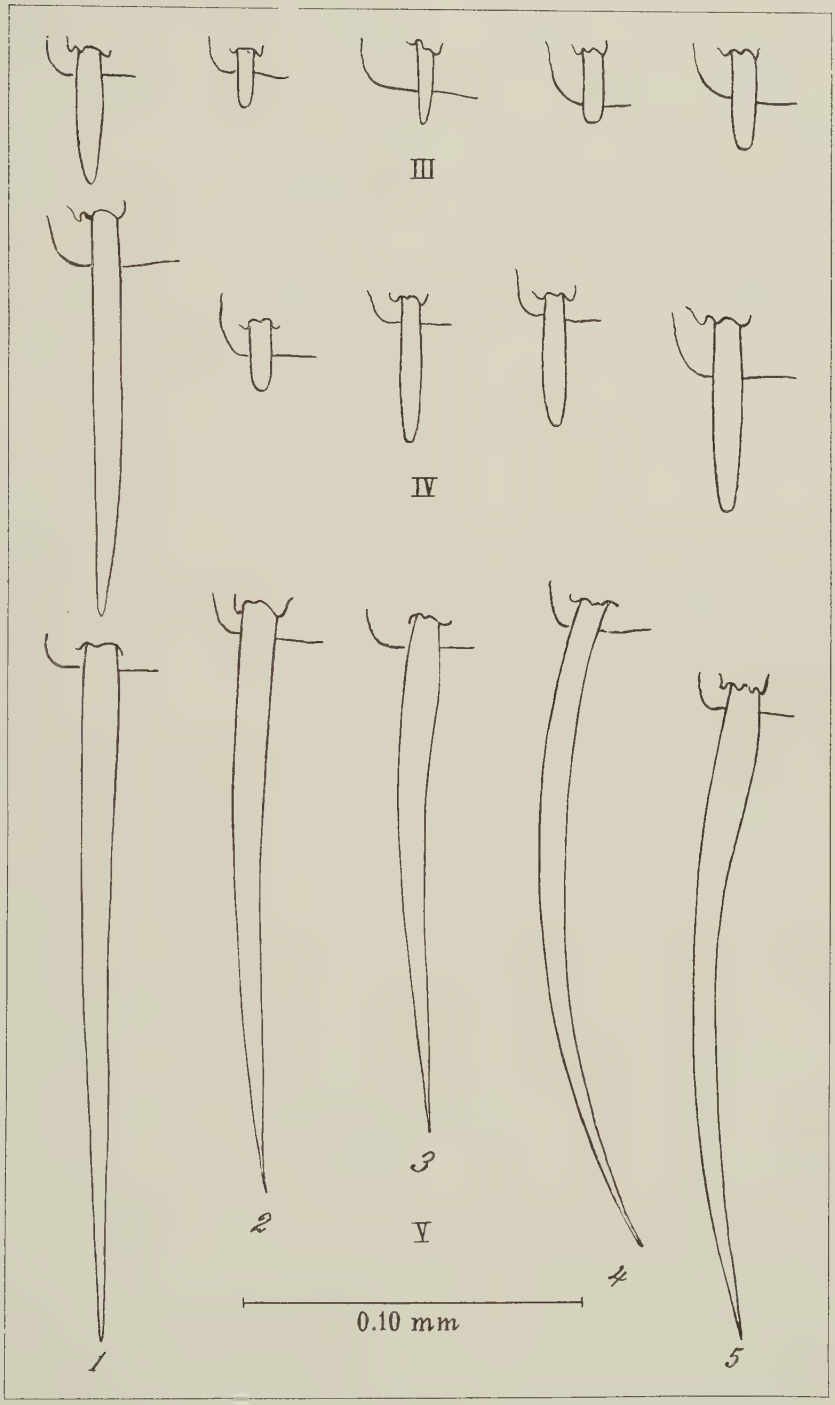

PLATE 18. PUPAL SPINES III TO V; GROUP PSEUDOMYZOMYIA.

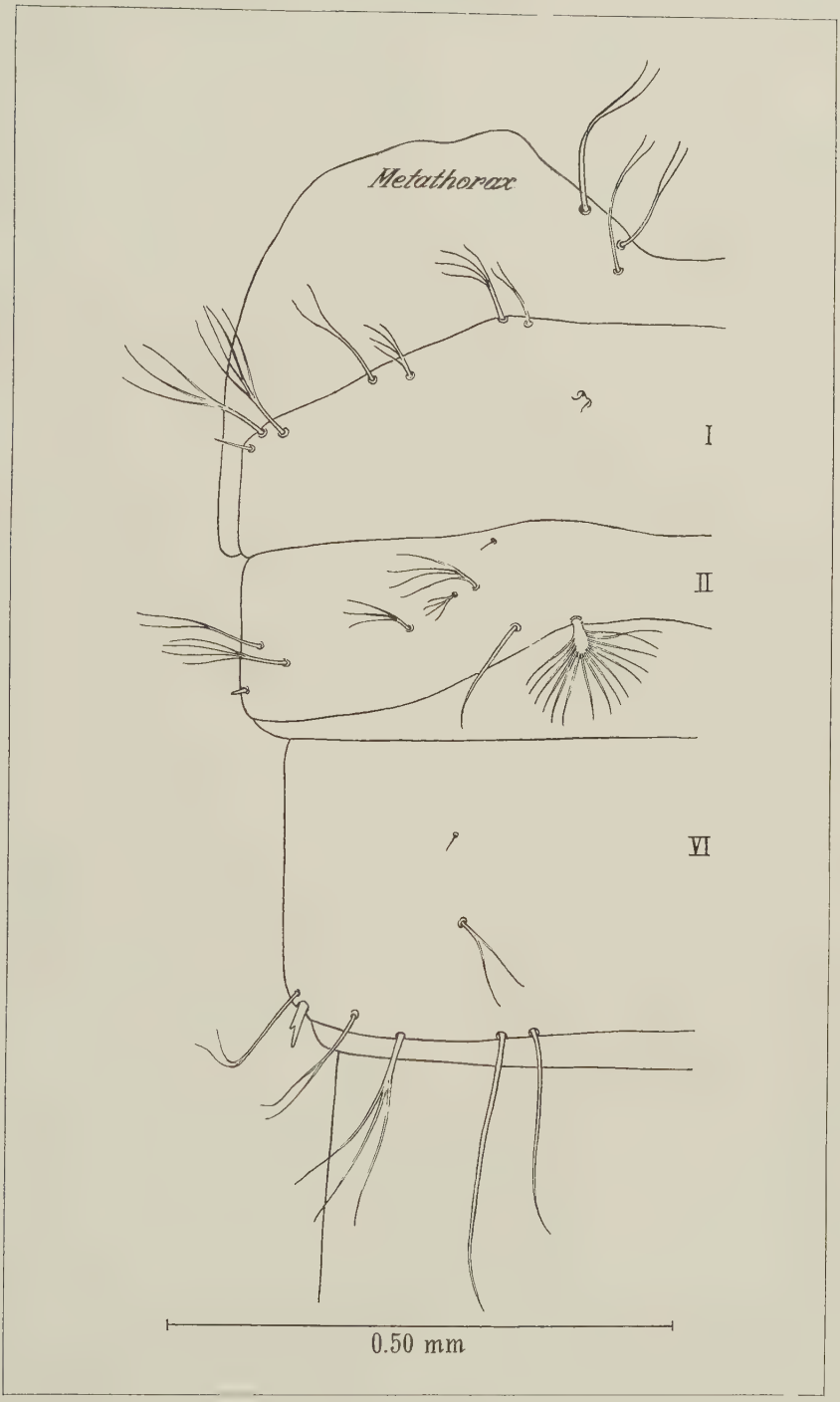

PLATE 19. ANOPHELES KOCHI.

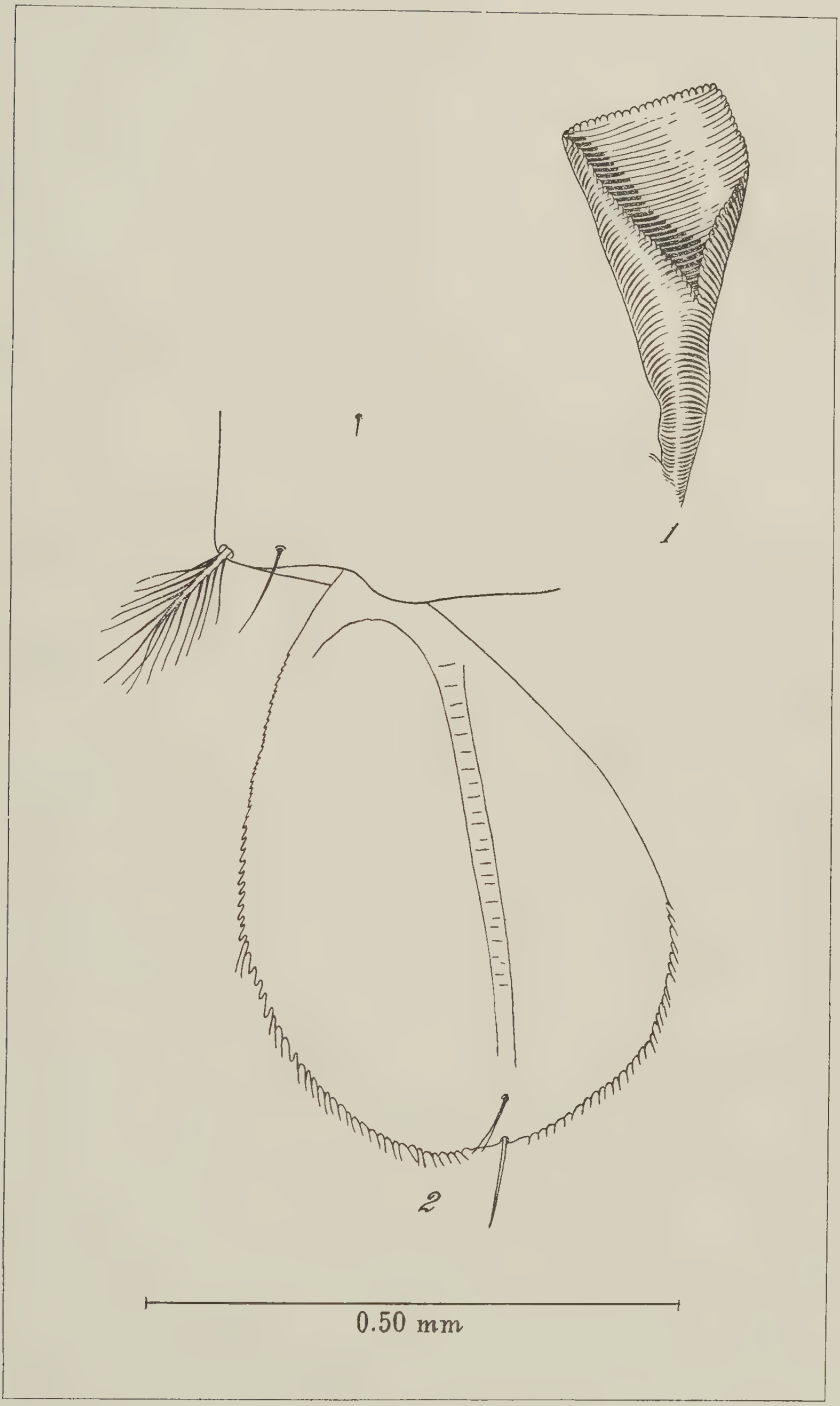

PLATE 20. ANOPHELES KOCHI.

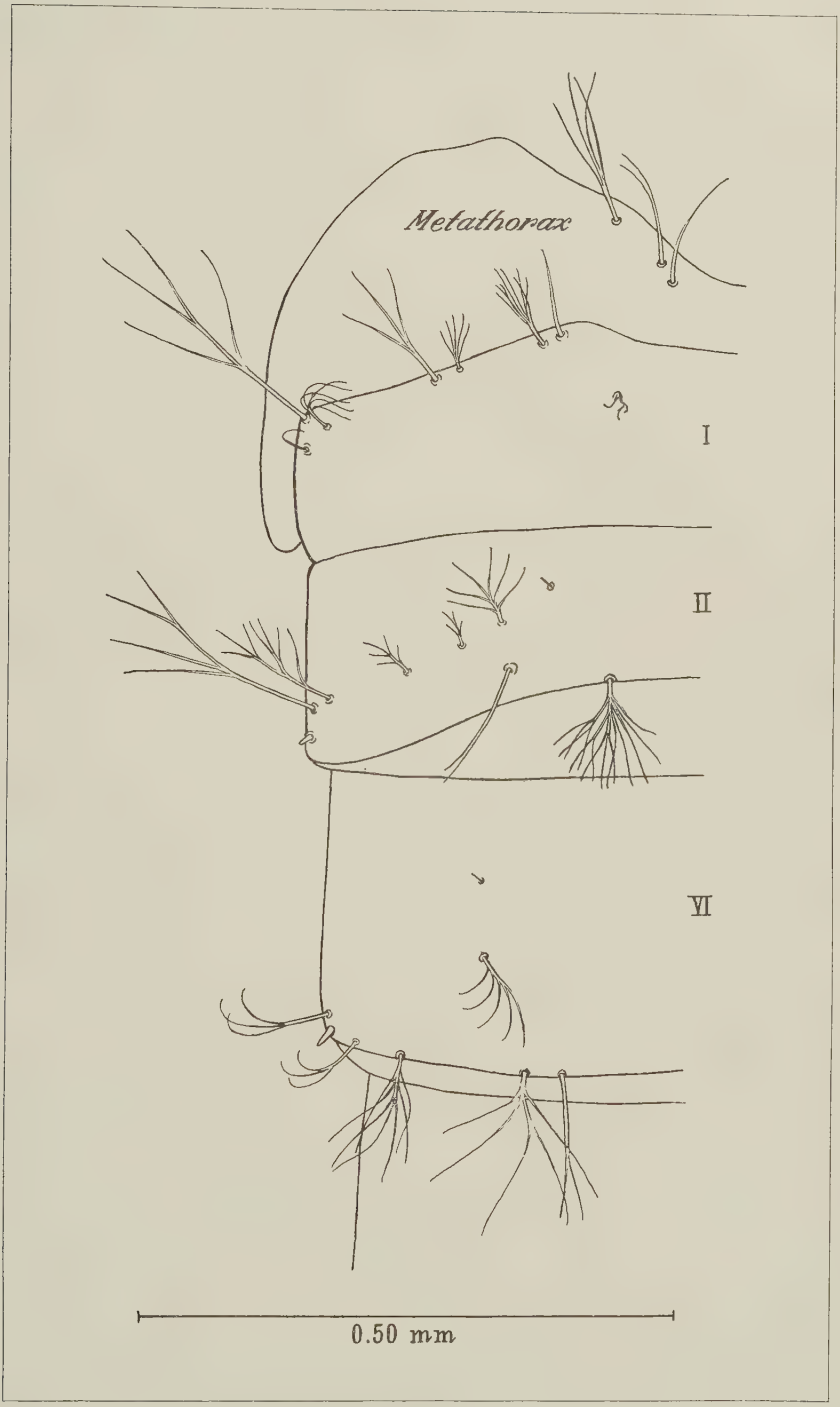

PLATE 21. ANOPHELES TESSELLATUS.

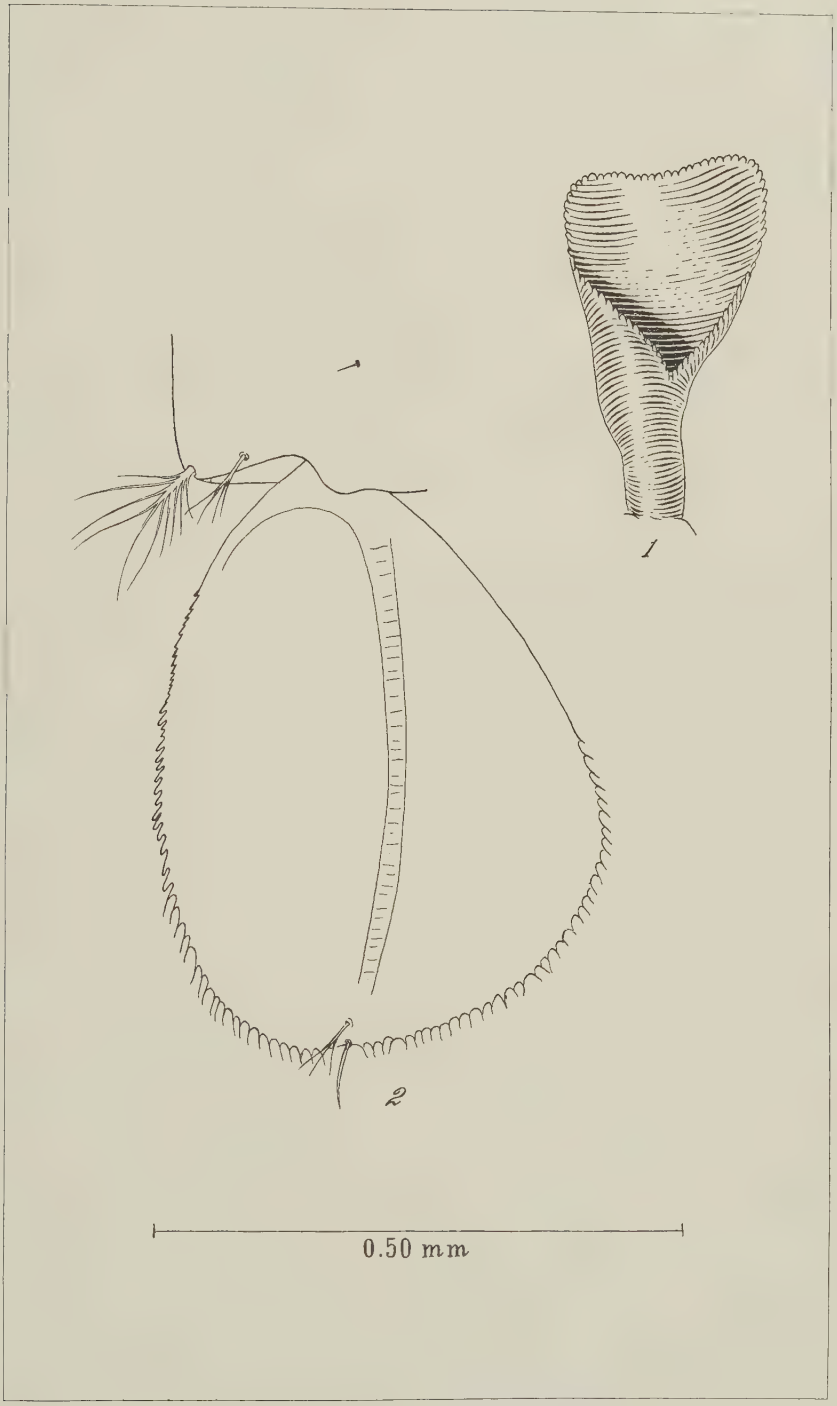

PLATE 22. ANOPHELES TESSELLATUS.

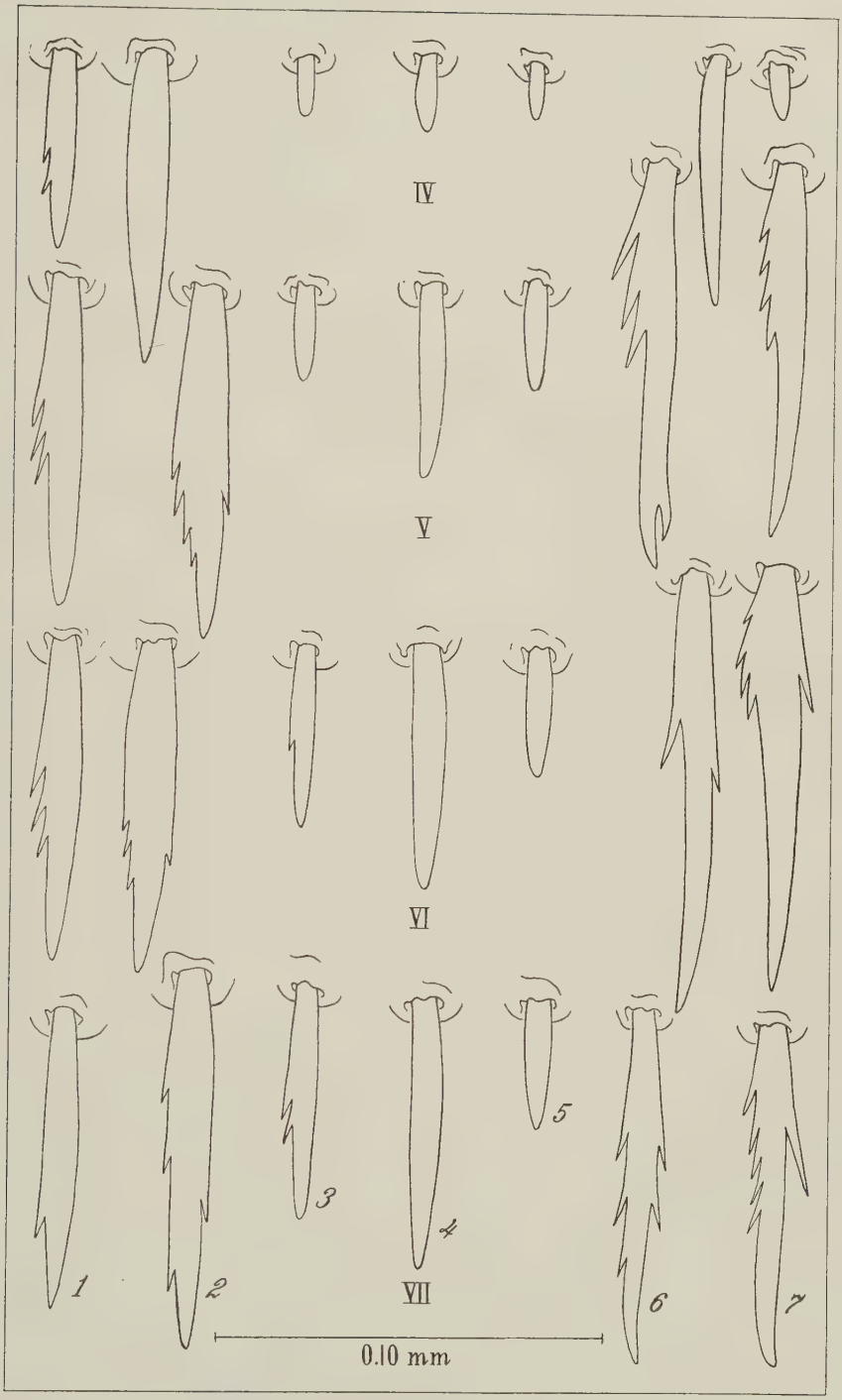

PLATE 23. PUPAL SPINES IV TO VII; GROUP NEOMYZOMYIA.

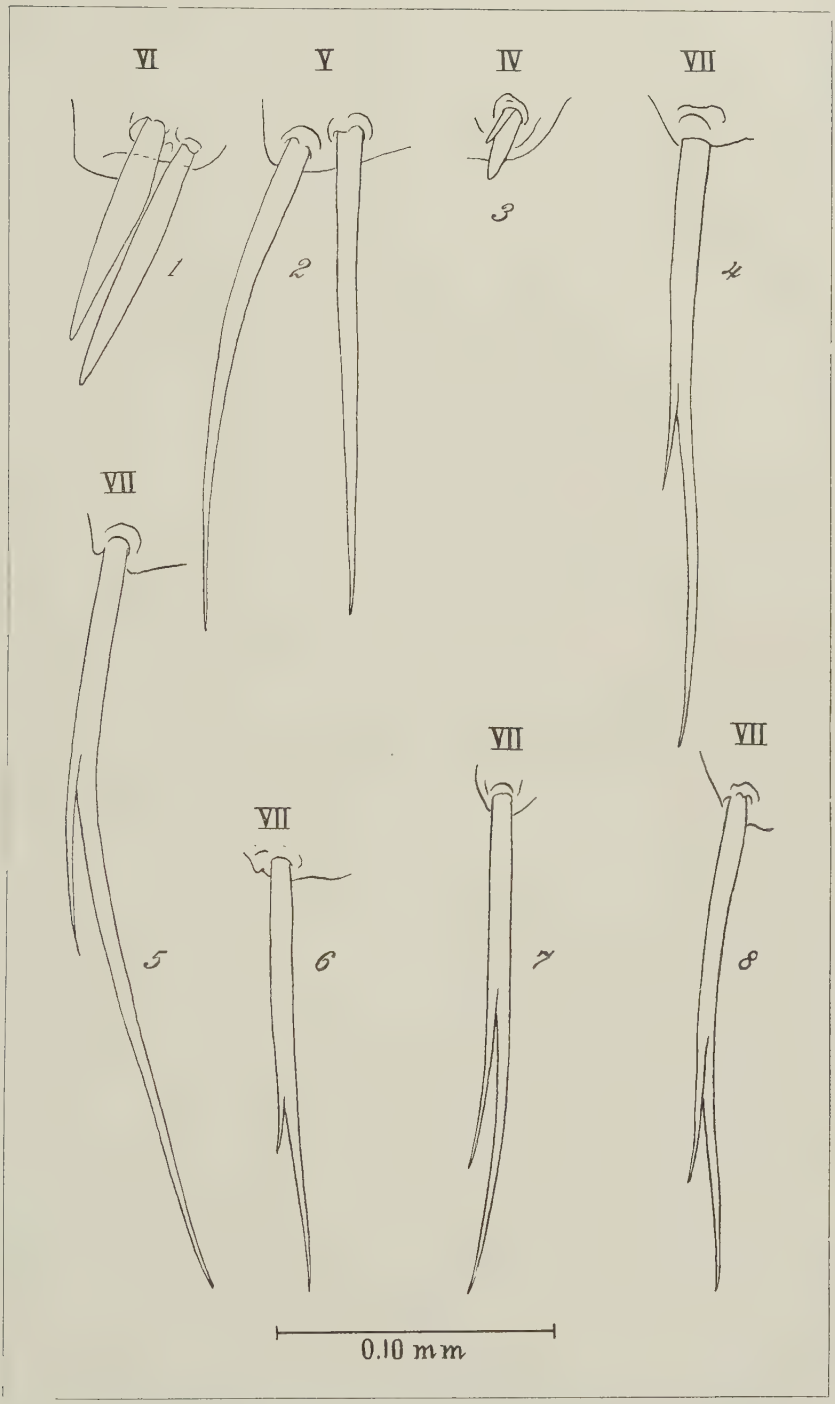

PLATE 24. DUPLICATION AND SPLITTING OF PUPAL SPINES.

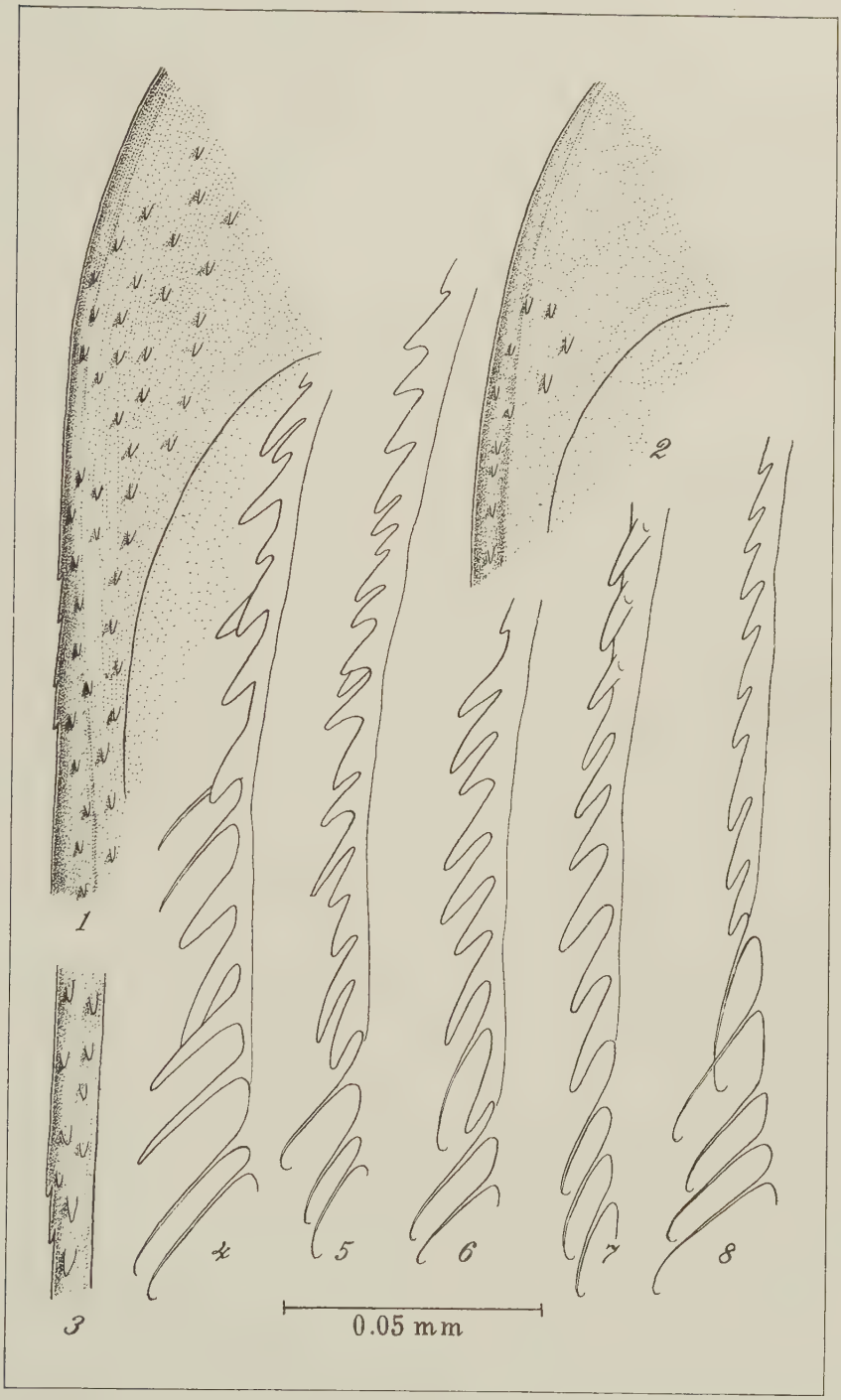

PLATE 25. DENTICLES AND ACCESSORY DENTICLES OF PADDLE; GROUP PSEUDOMYZOMYIA.

FURTHER OBSERVATIONS ON THE LIFE CYCLE OF GNATHOSTOMA SPINIGERUM [1]

By CANDIDO M. AFRICA, PEDRO G. REFUERZO, and EUSEBIO Y. GARCIA

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In a recent study we (Africa, Refuerzo, and Garcia, 1936) reported the occurrence of encysted gnathostome larvæ (presumably of *G. spinigerum*) in the muscles of three species of fresh-water fishes (*Glossogobius giurus, Ophiocephalus striatus,* and *Therapon argenteus*), which when fed to white rats have been found to undergo development both in size and structure in the liver and skeletal muscles of these animals. We, therefore, advanced the tentative view that suitable and unsuitable hosts possibly get *Gnathostoma* infestations not by drinking water containing infected cyclopes as suggested by Prommas and Daengsvang (1933) following their success in infecting this crustacean with larvæ from hatched eggs of *G. spinigerum,* but by eating raw fresh-water fish containing encysted gnathostome larvæ. While we were putting our view to further experimental tests, on cats this time, Prommas and Daengsvang (1936) reported their successful experimental infection of *Clarias batrachus* (a fresh-water fish) with encysted gnathostome larvæ by feeding it with experimentally infected cyclopes. We are reporting here the results of our feeding of a cat with encysted gnathostome larvæ from naturally infested fish and our finding on six naturally infested aquatic snakes.

EXPERIMENT

Through the kindness of Dr. Marcos Tubangui, chief of the biological division of the Bureau of Science, Manila, we were able to obtain two adult cats which were reared from the litter under conditions that seem to preclude any possibility of their having contracted gnathostome infestation insofar as water and food or caging conditions were concerned. The two cats had

[1] Aided by a special research grant from the Board of Regents, University of the Philippines. Submitted for publication July 20, 1936.

never been given fish as part of their diet, and they had, as far as we are aware, absolutely no access to fish, accidentally or otherwise. One of the two cats was given per orem 4, 7, and 5 encysted gnathostome larvæ obtained from the flesh of *Glossogobius giurus* January 22, January 25, and February 14, 1936, respectively. The other cat was used as control. The two cats were placed in separate metal cages with screened floor far from other animals, and extreme precautions were taken to avoid giving them food or water other than those prescribed during the course of the experiment. Both cats were negative for helminth eggs at the start of our work.

About one and one-half months after the first feeding the droppings from the two cats were examined for gnathostome eggs from time to time, but both cats were consistently negative throughout the experiment. As we were getting impatient waiting for the appearance of the eggs and curious about the result of our feeding, we decided to sacrifice the experimental cat May 18, 1936, exactly 3 months 26 days after the first infection. On opening the stomach two nodules were found in the fundus; the larger one, which apparently had established a communication with the gastric lumen, contained two apparently mature gnathostomes (male and female); and the smaller nodule, which did not show any communication at all with the gastric cavity, contained one semimature worm. Two semimature worms were also found in the diaphragm. The intestines and other internal organs were free from infestation. The fæcal contents of the large intestine did not show the presence of eggs after repeated microscopic examination of concentrated samples.

The following are the measurements of the male and female worms recovered from the larger stomach nodule of our infested cat.

		Male.	Female.
Length	mm	12	14
Diameter	mm	0.612	0.75
Globular cephalic swelling	mm	0.512 x 0.230	0.50 x 0.250
Œsophagus	mm	2.2 x 0.525	0.30 x 0.625
Intestine, length	mm	7.6	8.00
Transverse rows of cephalic hooklets		8	11
Size of hooklets	mm	0.016 x 0.010	0.016 x 0.010

The anterior body spines are broad and have three, sharp, terminal points; the posterior body spines are narrow and have only one point. The number of rows of cephalic hooklets in the semimature worms obtained from the smaller stomach nodule and diaphragm varies from eight to nine.

The control cat was sacrificed May 25, 1935, and was found negative after an extensive search for evidence of infestation in the stomach, intestine, liver, muscles, and other internal organs.

GNATHOSTOME LARVÆ IN SNAKES

An opportunity to study gnathostome larvæ in reptiles was presented when six aquatic snakes, *Hurria rhynchops* (Schneider), were brought to our laboratory from Bulacan, a province near Manila. Dissection of these snakes revealed a large number of gnathostome larvæ (presumably of *G. spinigerum*) encysted in the mesentery and muscles immediately surrounding the parietal peritoneum. Some apparently semimature forms were also embedded just underneath the skin. The encysted larvæ have four transverse rows of cephalic hooklets and in size and structure resemble the ones found by us in the flesh of fresh-water fishes. The semimature ones found under the skin have from four to five transverse rows of cephalic hooklets and are considerably larger than the encysted ones. Because of the lack of available laboratory animals at the time the snakes were brought to us no feeding experiment was made, which we greatly deplore.

REMARKS

The two mature (male and female) worms obtained from a typical stomach nodule of our experimentally infested cat and the three semimature worms, one of which was also found in the stomach and the other two in the diaphragm, presumably resulted from our feeding of this animal with encysted larvæ of *Gnathostoma* from the flesh of *Glossogobius giurus* (a fresh-water fish), which together with *Ophiocephalus striatus* and *Therapon argenteus* (also fresh-water fishes) had previously been found naturally infested with these larvæ. The difficulty of finding cats that are absolutely free from infestation did not permit us to use a larger number of cats in this experiment, but we were satisfied by the assurance of Doctor Tubangui that

the two cats he gave us could be considered "clean" insofar as gnathostome infestation was concerned.

Morphologically the adult worms obtained from one of the stomach nodules answer faithfully the description of *G. spinigerum* even to the detail of the body spines as given by Faust (1929). The number of transverse rows of cephalic hooklets is 8 in the male and 11 in the female, a fact which confirmed the findings of Baylis and Lane (1920) that the number of transverse rows of cephalic hooklets in *Gnathostoma spinigerum* varies from 8 to 11. The five adult gnathostomes that we recovered from stomach nodules of naturally infested cats during our previous study of this subject all had 9 transverse rows of cephalic hooklets.

The absence of eggs in the fæces of our experimentally infested cat may merely indicate that oviposition had not yet commenced at the time our animal was sacrificed. Perhaps we could have recovered eggs in the fæces of this animal had we delayed our autopsy for a few weeks.

The consistent failure of Prommas and Daengsvang (1933 and 1936) to infect cats with cyclopes containing *G. spinigerum* larvæ from 7 to 30 days old, and their (1936) success in infecting a fresh-water fish (*Clarias batrachus*) with encysted larvæ by feeding it with experimentally infested cyclopes; our accidental finding of encysted gnathostome larvæ in the flesh of three species of fresh-water fishes under natural conditions; and finally, our successful infestation of a presumably "clean" cat with adult gnathostomes occurring in a typical stomach nodule by feeding this animal with encysted larvæ from naturally infested *Glossogobius giurus*, all seem to point definitely to the fact that gnathostomes require in their life cycle a second intermediate host in the form of a fresh-water fish.

Our finding of gnathostome larvæ apparently of two distinct groups with regard to size and degree of development in *Hurria rhynchops* (Schneider) has developed a peculiar situation insofar as snakes are concerned in the life cycle of *G. spinigerum*. In our first paper on this subject (Africa, Refuerzo, and Garcia, 1936) we remarked that the fact that the larvæ which Chandler (1925) recovered from snakes approximate both in size and structure the encysted larvæ from the flesh of fishes would imply that the snakes act in the same capacity as the fishes, which even at that time we already believed to be the second intermediate host of *G. spinigerum*. On the other hand, we mentioned the possibility of the snakes assuming the

rôle of the so-called unsuitable host of this nematode; that is, one that would allow the development of the worm only up to a certain stage short of maturity and not become a second intermediate host.

SUMMARY

A cat, presumably free from previous infestation of *G. spinigerum*, has been successfully infested with this gnathostome by feeding it with encysted larvæ from a naturally infested *G. giurus* (a fresh-water fish). This result tends to confirm the view we advanced in a previous work (Africa, Refuerzo, and Garcia, 1936) that suitable and unsuitable hosts of *G. spinigerum* possibly get their infestation not by drinking water containing infected cyclopes, but by eating infested fresh-water fishes which in turn have eaten infected cyclopes.

Our finding of two apparently different groups of gnathostome larvæ in *Hurria rhynchops* (Schneider), an aquatic snake, indicates that the possible rôle of snakes in the life cycle of *G. spinigerum* needs further study.

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SOMATIC HETEROPHYIDIASIS IN FISH-EATING BIRDS, II

PRESENCE OF ADULTS AND EGGS IN THE BILE DUCTS OF THE CATTLE EGRET [1]

By CANDIDO M. AFRICA, WALFRIDO DE LEON, and EUSEBIO Y. GARCIA

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TWO PLATES

As we were curious to know if *Monorchotrema taihokui* and *M. taichui* show the same proclivity to invade the internal organs in their bird host as they do in man(1, 2, 3, 4) and encouraged by our success in finding what appears to be an extension of *Stictodora* infestation from the small intestine to the pancreas in a sea gull (*Larus ridibundus* Linn.),(5) we examined a large number of cattle egrets (*Bubulcus ibis coromandus* Boddaert), which we previously found to harbor both these heterophyids in the small intestine, and discovered large concentrations of eggs (presumably of these flukes) as well as adult parasites in the bile ducts of three of the twenty-seven birds dissected. Fifteen of the egrets showed the presence of one or both of these heterophyids in the small intestines, an incidence of 55.4 per cent. No evidence of extension of the infestation was found in the following organs: Pancreas, spleen, heart, kidneys, and lungs. This report deals chiefly with our findings in the liver of this bird.

TECHNIC AND MATERIALS

The twenty-seven egrets examined in this work were bought from a dealer who caught them at different points along the shore of Laguna de Bay, a fresh-water lake about 25 kilometers south of Manila, Luzon. The technic we followed in this investigation is more or less similar to the one we adopted in our investigation in human heterophyidiasis,(4) and hence will not be redescribed here. After determining the presence of

[1] Aided by a special research grant from the Board of Regents, University of the Philippines.

either one or both of these heterophyids in the small intestine of this bird, the liver, pancreas, kidneys, heart, lungs, and spleen were isolated, removed, and preserved. Multiple blocks were cut from each of the above-mentioned organs for serial sectioning. It is felt that each of the organs mentioned above has been sufficiently covered or explored in each bird for the purpose of this work.

DESCRIPTION OF THE LESIONS

In this paper we are limiting ourselves to the consideration of the liver alone since no evidence of the extension of the infestation to the other organs has been found.

Grossly the infested liver does not show any abnormality that would differentiate it from the uninfected one. Except in portal areas that happen to contain collections of heterophyid eggs or, occasionally, what appear to be adult flukes or remnants of them, even the examination of histological sections has failed to reveal any marked abnormality other than evidence of mild degenerative changes due to pressure observed here and there in the parenchymatous areas. Actual hæmorrhage or any recent or remote indication of it is conspicuously lacking. The parasites are confined within the portal area, invariably in the immediate vicinity of the portal vessels; no evidence of their presence is found in other areas. This finding suggests that the flukes probably arrived in the liver from the intestine by way of the bile passages. Whenever the fluke or flukes show long residence in the locality as indicated by the complete disappearance of any remnants of them except their eggs, a definite chronic inflammatory reaction in the form of a fibrotic capsule with leucocytic infiltration, mostly of the round-cell variety, is observed around the parasites. Eosinophiles are conspicuously absent. Scattered here and there along this fibrotic wall, mostly on the outside, are islets of bile epithelium, indicating attempts at regeneration of the destroyed bile ducts. Within the fibrotic capsule and in direct contact with the egg collection are numerous endothelial cells, some of which have fused to form giant cells. The flukes that have just arrived in the bile ducts, as indicated by beautifully stained reproductive glands and well-stained miracidia within their eggs, are not surrounded by any marked cellular reaction, except that the bile duct containing the parasite is greatly dilated, the epithelium is obliterated, and there is a very scanty fibrotic formation which is devoid of any leucocytic infiltration. The sheets or masses of

cells of the type we found in vascular lesions primarily caused by heterophyid eggs in human cardiac and cerebral heterophyidiasis,(2, 3, 4,) as well as in heterophyid infestation in the pancreas of a sea gull (*Larus ridibundus*),(5) have not been observed in any of the sections in the present material.

DISCUSSION

The evidence we have gathered in this paper tends to show that *Monorchotrema taihokui* and *M. taichui* do not behave in the bird as they do in their human host. The tendency to invade the general circulation and consequently internal organs quite remote from their intestinal habitat which we have observed recently in human infestations with these flukes,(1, 2, 3, 4) appears to be absent in their avian host. At least insofar as the cattle egret is concerned, the farthest organ from the intestine they have reached is the liver, which they seem to invade not through the agency of the blood circulation but through the bile passages. That this tendency to invade the bile ducts seems to be rather unusual in the avian host is indicated by the fact that of fifteen birds positive for either *M. taichui* or *M. taihokui,* or both, only three showed flukes or evidence of their presence in the liver.

This finding raises the question as to whether the cattle egret is the normal host of these heterophyids. The term normal host (used here advisedly) implies an animal which allows a parasite to run a normal course of parasitic existence conducive to its proper propagation and well-being and which on the other hand suffers a minimum of damage in doing so. This necessarily involves a state of adaptation between the host and the parasite which is gradually developed in proportion to the length of time of their parasitic association, the tendency being to arrive at a condition of perfect adjustment between parasite and host. That the adjustment between these *Monorchotrema* spp. and their human host is not as good as that which they enjoy in their avian host would appear from the fact that we frequently found the eggs of these heterophyids in the fæces of infected birds without the use of any special technic other than ordinary fæcal-smear examination, a thing which we were not able to do in human heterophyid infestation even in cases where adult flukes were recovered in the intestinal scrapings.

The parasitic relationship between these heterophyids and their avian host appears to be more balanced and, therefore, more conducive to a normal parasitic existence. In other words

a parasitic relationship wherein a condition of "live and let live" is attained appears to have been developed after long and continuous contact between *M. taihokui* and *M. taichui* on the one hand and the cattle egret (*Bubulcus ibis coromandus*) on the other. These heterophyids do not seem to have the tendency to invade the circulation in their bird host, and although some of them may wander to the bile passages of the liver, this migration does not seem to be a usual or normal occurrence, as has been pointed out above. Those flukes that happen to be in the bile ducts seem to produce too little damage to endanger the life of the host. For this reason we feel inclined to hold the view that this cattle egret permits normal parasitic development of these heterophyids and acts as one of the reservoir hosts whose droppings pollute the water where the appropriate snail host may be found. This view is supported by our finding of the metacercaria of *M. taihokui* in two species of fresh-water fishes (*Arius manilensis*, "kanduli;" and *Clarias batrachus*, "hito") in Laguna de Bay, along the shore of which this bird abounds. In this connection it may be of interest to note that a human infestation with *M. taihokui* with myocardial complication has been reported by Africa, de Leon, and Garcia(4) from Biñan, a town on the shore of the above-mentioned lake.

On the other hand, as a result of an unbalanced parasitic relationship that seems to exist between these heterophyids and their human host, these flukes, as shown in our previous publications, seem to have the tendency to penetrate far into the deeper layers of the wall of the small intestine after excystment and therein to die, disintegrate, and give up their eggs, which are later absorbed by the blood stream and deposited in remote organs of the body. In this manner these flukes not only tend to shorten the life of their human host, but also lose their opportunity to expel their eggs through natural and proper channels. This fact perhaps explains the apparent absence of their eggs in the fæces of infested persons. Such a condition is far from being conducive to successful parasitism, which consists chiefly in the ability of the parasites to do the least damage possible to their host and at the same time live, reproduce, and provide natural exit for their young in order to reach new hosts for the perpetuation of their kind.

The present finding in the cattle egret is quite analogous to what we(5) have observed in a sea gull (*Larus ridibundus*), in the pancreas of which we found numerous huge collections of eggs, presumably of *Stictodora* spp., which occurred in large

numbers in the small intestine of this bird. The small number of birds examined in this work does not warrant the assumption that these species of heterophyids confine their migration to the pancreas in this bird, for further dissection may reveal their presence in other organs also, especially the liver. Evidence gathered so far seems to show that in *Stictodora* infestation the invasion of the pancreas is by way of the pancreatic duct, even as the invasion of the liver in the *Monorchotrema* spp. infestation is through the bile duct. In the event that these two groups of heterophyids are finally proven to have a specific affinity for the respective organs mentioned above, an inexplicable phenomenon, analogous to the specific affinity of the three human schistosomes for the different tributaries of the portal vein, will be established since the bile duct and the pancreatic duct have a common stem from the intestinal lumen.

SUMMARY

Of twenty-seven cattle egrets (*Bubulcus ibis coromandus* Boddaert) examined fifteen showed the presence of either *Monorchotrema taihokui* or *M. taichui,* or both, in the small intestine, and three of the infested birds showed extension of the infestation to the bile ducts of the liver, but none in other internal organs. The flukes appear to have invaded the liver through the bile ducts, there being neither evidence of vascular disturbances in the infested organ nor signs of the presence of flukes or their remnants in areas other than the immediate vicinity of the portal vessels. The lesions found consist of chronic inflammatory reaction in the form of fibrotic capsules with leucocytic infiltrations, mostly of the round-cell variety, surrounding the parasites, and hyperplastic changes of the bile ducts. The hostal relations of *M. taihokui* and *M. taichui* with their human and avian hosts are discussed, and the possibility of the cattle egret acting as a reservoir host of these heterophyids is suggested.

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ILLUSTRATIONS

Plate 1

Fig. 1. Photomicrograph (low power) of a section of the liver of a cattle egret (*Bubulcus ibis coromandus* Boddaert) showing transverse sections of two flukes in a greatly dilated bile duct. Note the scanty fibrotic capsule around the parasites.

2. Photomicrograph (low power) of another section of the same liver showing a collection of eggs surrounded by a thick fibrotic capsule with leucocytic infiltration mostly of the round-cell variety. Note (*a*) hyperplastic bile ducts, (*b*) giant cells, (*c*) portal vein.

Plate 2

Fig. 1. The same section as in Plate 1, fig. 1, under high magnification.

2. The same section as in Plate 1, fig. 2, under high magnification, showing the character of the fibrotic capsule surrounding the empty eggs and the giant cells trying to engulf the eggs at the periphery of the collection.

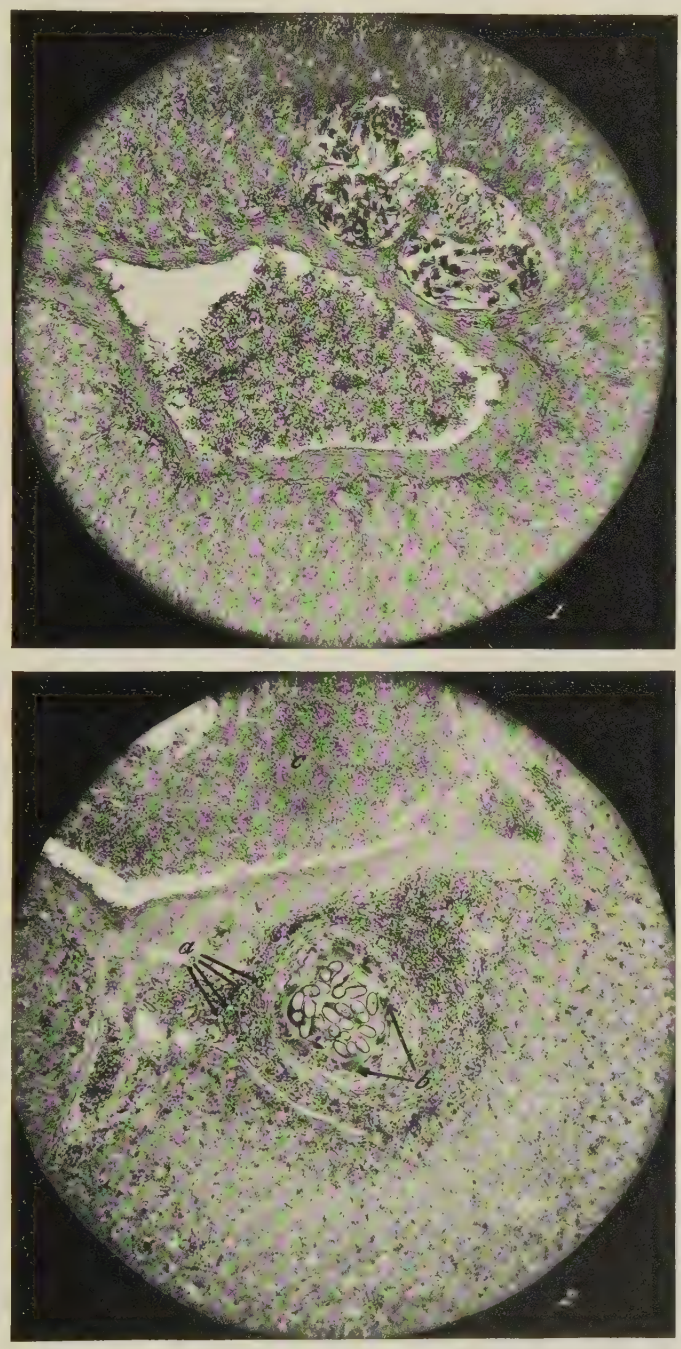
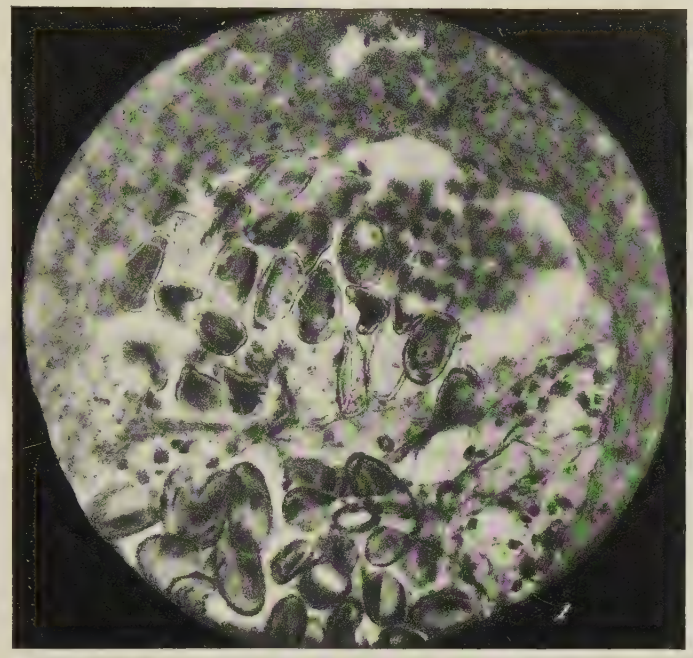


PLATE 1.



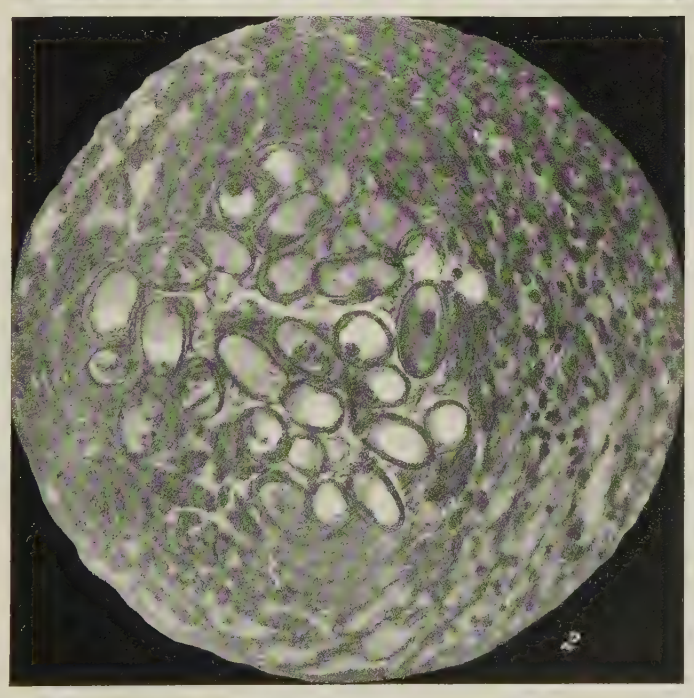


PLATE 2.

BORNEAN MOSSES, PRINCIPALLY FROM MOUNT KINABALU

By Edwin B. Bartram

Of Bushkill, Pike County, Pennsylvania

ONE PLATE

During the latter part of 1933 Mr. and Mrs. Joseph Clemens actively collected mosses in the Kinabalu region, Borneo, at altitudes between 3,500 and 12,500 feet. The details of this collection can now be recorded without fear of duplicating any of the new species included in Dixon's important paper.[1]

The presence of five new species and three new varieties in addition to eighteen species not previously known from Borneo emphasizes again the almost inexhaustible riches of this tropical flora.

An especially interesting isolated group from the higher elevations of Kinabalu up to 12,500 feet includes *Andreaea petrophila* var. *rubicunda, Grimmia ovalis,* and *Rhacomitrium crispulum,* all of them new to Borneo and showing a wide break in geographic distribution. Further explorations of this high granite dome will probably reveal more species of the affinities.

Included in the list are a few collections by E. Mjoberg from Mount Tibang, located near the junction of the Kapuas and Iran Mountain Ranges in the upper center of the island, which came from the Farlow herbarium.

Unless otherwise indicated the collections listed below are by J. and M. S. Clemens from Mount Kinabalu.

ANDREAEACEÆ

ANDREAEA PETROPHILA Ehrh. var. RUBICUNDA var. nov.

Folia conferta, sicca suberecta, saepe rotundato-obtusa, intense rubra.

Borneo, Gurulau Spur, base of Victoria Peak, on granite slope, elevation 12,500 feet, *Clemens s. n.*

A significant range extension of this species as broadly interpreted, and a suggestive addition to the Bornean flora indicating a closer bond with the Himalaya region than with any other.

[1] Linn. Soc. Journ. 1 (1935) 57–140.

FISSIDENTACEÆ

FISSIDENS ASPLENIOIDES Hedw.

On rock near Dehobang Falls, Penibukan, elevation 5,000 feet, *Clemens 40290d.*

New to Borneo. The nearest records for this species are from Java and Sumatra.

DITRICHACEÆ

DITRICHUM FLEXIFOLIUM (Hook.) Hpe.

Gurulau Spur, elevation 10,000 feet, on rocks, north of Paka, Kadamian River, head of low jungle; Gurulau Spur, base of Victoria Peak, elevation 12,500 feet, on granite slope.

DICRANACEÆ

DICRANELLA SETIFERA (Mitt.) Jaeg.

Tenompok, yellow soil in damp exposed place, elevation 5,000 feet.

CAMPYLOPUS HEMITRICHIUS (C. M.) Jaeg.

Pinokkok Falls, elevation 6,500 feet, on wet rocks; Penibukan, on wet rocks near Pinokkok Falls, elevation 6,500 feet, *Clemens 40975a.*

New to Borneo. Previously known only from the Philippines.

CAMPYLOPUS UMBELLATUS (W. Arn.) Bartr.

Masilan River, elevation 6,000 feet, *Clemens 51378;* Gurulau Spur, elevation 8,000 feet, on rocks in stream bed, *Clemens 51211;* Gurulau Kamboranga, elevation 8,000 feet; Tenompok, damp rock, elevation 5,000 feet.

CAMPYLOPUS EXASPERATUS Brid.

Gurulau Spur, elevation 7,000 to 8,000 feet, *Clemens 51444;* South Gurulau Spur, elevation 7,000 to 8,000 feet, on trunks, logs, etc., *Clemens 51666;* jungle trail below Gurulau Kamboranga, on trees, elevation 6,000 to 8,000 feet, *Clemens 51047a;* Masilan, near ford, elevation 7,000 feet, *Clemens 51654a;* Gurulau Spur, near Gurulau Kamboranga, elevation 8,000 to 9,000 feet, *Clemens 50838b;* Penibukan, near Pinokkok Falls, elevation 6,500 feet, *Clemens 40975;* Gurulau Spur, margin of recent landslide, North Paka and Kadamian River, elevation 10,500 feet, *Clemens 50885.*

DICRANODONTIUM NITIDUM Fleisch. var. CLEMENSIAE var. nov.

Cellulae basilares chlorophyllosae magis fortiter porosae.

BORNEO, Mount Kinabalu, Gurulau Spur, elevation 7,000 to 8,000 feet, in dense masses on trail and trees, *Clemens 51029*

type, *51438;* Gurulau Spur, elevation 7,000 to 8,000 feet, mossy forest dripping, *Clemens 51030;* jungle trail below Gurulau Kamboranga, on trees, elevation 6,000 to 8,000 feet, *Clemens 51047b;* Gurulau Spur, jungle trail below Gurulau Lobang and Kamboranga, *Clemens 51045.*

This seems to be a well-marked variant and is possibly the form noted by Dixon.[2] The leaves in the specimens noted here are, however, if anything, wider than usual towards the base; the area of clear rectangular cells is sharply defined from the very narrow marginal cells of the leaf base and grades abruptly into the chlorophyllose cells above, which are very incrassate with strongly porose pellucid lateral walls.

HOLOMITRIUM VAGINATUM (Hook.) Brid.

Penibukan Ridge, elevation 4,000 feet, on forest tree, *Clemens 40431.*

New to Borneo. Distribution: Java, Philippines, Pacific Islands.

DICRANOLOMA SUBECOSTATUM Dix.

Dicranoloma subenerve Broth.

Gurulau Spur, elevation 7,000 to 8,000 feet, on trees and ground, *Clemens 51100, 51034, 51445.*

DICRANOLOMA BREVISETUM (Doz. and Molk.) Par.

Penibukan, elevation 4,000 feet, ridge east of Dahobang River, on tree, *Clemens 50121.*

DICRANOLOMA BLUMII (Nees) Par.

Gurulau Spur, elevation 7,000 to 8,000 feet, *Clemens 51437, 51445a.*

DICRANOLOMA ANGUSTIFRONDEUM Dix.

Tenompok, elevation 5,000 feet, on dead log; Columbon River basin, on tree, bank above stream, elevation 4,500 feet.

DICRANOLOMA EURYLOMA Dix. var. RUGIFOLIUM var. nov.

Mount Tibang, elevation 1,600 m, *Mjoberg s. n.,* November, 1925.

Very close to *D. euryloma* and, in fact, inseparable except by the undulate leaves which give the plants a characteristic look. The subula varies considerably in length and the hyaline border in width, but no more so than in typical plants that I owe to the kindness of Mr. Dixon. The leaf cells are quite

[2] Op. cit. 72.

thin and poorly defined. The walls are relatively wide but of the same color as the lumens and hence quite indistinct.

LEUCOLOMA MOLLE (C. M.) Mitt.

Jungle ridge near Dahobang River, elevation 3,500 feet, *Clemens 40594d;* Penibukan, ridge below camp, on branch, elevation 3,500 feet, *Clemens 50053c.*

BRAUNFELSIA SCARIOSA (Wils.) Par.

Masilan River, elevation 6,000 feet, *Clemens 51380a, 51486;* Gurulau Spur, elevation 7,000 to 8,000 feet, *Clemens 51440;* Penibukan, near Pinokkok Falls, on rocks, wet jungle, elevation 6,000 feet, *Clemens 40934b.*

BRAUNFELSIA PLICATA (Lac.) Fleisch.

Penibukan, near Pinokkok Falls, on rocks, wet jungle, elevation 6,000 feet, *Clemens 40934a.*

LEUCOBRYACEÆ

LEUCOBRYUM SANCTUM Hpe.

Mount Tibang, elevation 1,400 m, *Mjoberg s. n.,* November, 1925.

LEUCOBRYUM TEYSMANNIANUM Doz. and Molk.

Penibukan, on log in jungle, elevation 4,500 feet, *Clemens 40713b.*

LEUCOBRYUM JAVANENSE (Brid.) Mitt.

Penibukan Ridge, on log, elevation 3,600 feet, *Clemens 40945c.*

LEUCOBRYUM PULCHRUM Broth.

Gurulau Spur, elevation 7,000 to 8,000 feet, mossy forest, on earth, *Clemens 51031.*

CLADOPODANTHUS PILIFER Doz. and Molk.

Jungle ridge above camp, on tree, elevation 4,500 feet, *Clemens 50305b;* Penibukan, elevation 4,000 feet, on twigs of tree, *Clemens 40531a.*

These specimens are meager, just a few plants in each case segregated from other mosses, but enough for identification.

New to Borneo. Distribution: Java.

CLADOPODANTHUS SPECIOSUS (Doz. and Molk.) Fleisch.

Penibukan, elevation 6,000 feet, near Pinokkok Falls, on rocks, wet jungle, *Clemens 50280;* Penibukan, elevation 5,000 feet, west ridge, jungle, *Clemens 50280.*

EXODICTYON BLUMII (C. M.) Fleisch.

Penibukan, elevation 4,000 feet, between flanges of 250-foot tree, *Clemens 40658a.*

LEUCOPHANES CANDIDUM (Hornsch.) Lindb.

Penibukan, jungle ridge near Dahobang River, elevation 3,500 feet, *Clemens 40594e.*

CALYMPERACEÆ

SYRRHOPODON TRISTICHUS Nees.

Penibukan, wall by side of Pinokkok Falls, elevation 6,500 feet, *Clemens 40899a.*

SYRRHOPODON GARDNERI (Hook.) Schwaegr.

Jungle Spur, on bark of great tree, elevation 5,000 feet, *Clemens 50477a.*

THYRIDIUM JUNGQULIAN (Mitt.) Jaeg.

Penibukan, ridge below camp, elevation 3,500 to 4,000 feet, *Clemens 40431b, 50053b.*

POTTIACEÆ

WEISIA CONTROVERSA Hedw.

Damp places, elevation 3,500 feet.

New to Borneo. Distribution: Cosmopolitan.

BARBULA JAVANICA Doz. and Molk.

Penibukan, on rocks near Dahobang Falls, elevation 5,000 feet, *Clemens 40290b.*

New to Borneo. Distribution: Himalayas, Java, Sumatra, Celebes, Philippines.

GRIMMIACEÆ

GRIMMIA OVALIS (Hedw.) Lindb.

Gurulau Spur, base of Victoria Peak, elevation 12,500 feet, on granite slope, *Clemens 51517b.*

New to Borneo. Distribution wide in temperate regions and at high altitudes in the Tropics, but not recorded from Malaysia as far as I know.

RHACOMITRIUM CRISPULUM (H. f. and W.) H. f. and W.

Gurulau Spur, base of Victoria Peak, elevation 12,500 feet, on granite slope, *Clemens 51517.*

New to Borneo. Distribution: Fuegia, New Zealand.

These plants seem to represent one of the forms of this protean species with the leaves merely acute and lacking any

trace of a hair point. It is a wide extension in the geographic range of the species, but I can find no character of any importance by which it might be separated.

RHACOMITRIUM JAVANICUM Bryol. Jav.

Masilan River, on stones, forest, elevation 5,000 to 7,000 feet, unexplored region, *Clemens 51664.*

FUNARIACEÆ

FUNARIA CALVESCENS Schwaegr.

Masilan River, elevation 7,000 to 9,000 feet, near lobang, *Clemens 51282.*

BRYACEÆ

BRACHYMENIUM NEPALENSE Hook.

Gurulau Spur, jungle spur, on great tree near camp, elevation 5,000 feet, *Clemens 50479;* Masilan River, elevation 6,000 feet, *Clemens 51380;* Pinokkok Falls, on limb.

BRYUM NITENS Hook.

Penibukan, on rock near Dahobang Falls, elevation 5,000 feet, *Clemens 40290f.*

New to Borneo. Distribution: Nepal, Ceylon, Java.

RHODOBRYUM GIGANTEUM (Hook.) Par.

Head of Columbon River, elevation 5,000 to 7,000 feet, mossy forest.

MNIACEÆ

MNIUM ROSTRATUM Schrad.

Head of Columbon River, mossy forest, Keebamban River, elevation 5,000 to 6,000 feet; Masilan River, near lobang, elevation 6,000 feet, *Clemens 51283a.*

RHIZOGONIACEÆ

RHIZOGONIUM SPINIFORME (Hedw.) Bruch.

Numerous collections; from 3,500 to 6,500 feet elevation.

HYPNODENDRACEÆ

HYPNODENDRON BECCARII (Hpe.) Jaeg.

Penibukan, ridge, jungle log, elevation 4,500 feet, *Clemens 40557a;* Penibukan, ridge east of Dahobang River, elevation 4,000 feet, *Clemens 50075;* Columbon River basin, on tree, bank

above stream, elevation 4,500 feet, *Clemens 33923;* Tenompok, elevation 5,000 feet, on damp logs.

These collections are richly fruited and show the characteristic orange coloration and the smooth capsules mentioned by Dixon.

MNIODENDRON DIVARICATUM (Hornsch. and Reinw.) Lindb.

Penibukan, elevation 4,500 feet, on log, *Clemens 40567, 40713* Penibukan, Lobang 11, above Pinokkok, elevation 5,500 feet, *Clemens 50132a;* Penibukan, elevation 6,000 feet, near Pinokkok Falls, on log, *Clemens 50131.*

MNIODENDRON ARISTINERVE Mitt.

Gurulau Kamboranga, scrub forest, elevation 7,000 to 9,000 feet, *Clemens 50787;* Gurulau Spur, elevation 8,000 feet, south side of spur, mossy elfin jungles on rock, *Clemens 51177;* head of Pinokkok River, elevation 8,000 feet, *Clemens 50871.*

BARTRAMIACEÆ

PHILONOTIS (LEIOCARPUS) IMPERFECTA sp. nov.

Dioica, laxe caespitosa, gracilis, sordide viridis. Caulis pusillus radiculosus, apice in ramulos fasciculatum divisus. Folia erecto-patentia, anguste lanceolata, breviter acuminata, carinato-concava, 0.8 mm longa, ubique serrulata; marginibus erectis vel angustissime recurvis; costa valida, percurrens, dorso fere ad basin scabra; cellulae superiores oblongae, 7 ad 8 μ latae et 10 ad 20 μ longae, apice papillosae, parietibus tenuibus, basilares subsimiles, ad 25 μ longae. Seta 16 ad 18 mm longa, tenuis; theca subglobosa, erecta, ad 1.5 mm longa; peristomium imperfectum, simplex, profunde insertum, dentes aurantiaci, papillosi, brevissimi; spori 18 ad 24 μ.

BORNEO, Mount Kinabalu, damp place, June 7, 1932, *Clemens s. n.*

This neat little plant is evidently closely allied through the rudimentary peristome to *P. tjibodensis* (Fleisch.), but appears to be perfectly distinct in the erect-spreading leaves, shorter areolation, and especially by the shorter, broader leaf points with the costa percurrent or even ending below the apex.

PHILONOTIS SECUNDA (Doz. and Molk.).

Tenompok, damp soil, elevation 5,000 feet; Penibukan, elevation 5,000 feet, on rock near Dahobang Falls, *Clemens 40290.*

New to Borneo. Distribution: Sumatra, Java, Philippines.

SPIRIDENTACEÆ

SPIRIDENS REINWARDTII Nees.

Colombon River basin, elevation 7,500 feet, north wall below falls, *Clemens 33175;* Masilan River, elevation 8,000 to 9,000 feet, forest in unexplored region, *Clemens 51665.*

ORTHOTRICHACEÆ

MACROMITRIUM PERDENSIFOLIUM Dix.

Penibukan, elevation 4,000 feet, on logs and trees near camp, *Clemens 40757, 40836.*

MACROMITRIUM (GONIOSTOMA) CLEMENSIAE sp. nov.

Robustiusculum, caespitosum, caespitibus fuscescentibus, opacis. Caulis elongatus, dense ramosus, ramis circa 2 cm longis, dense foliosis. Folia ramea sicca erecto-flexuosa, humida squarroso-recurvata, spiraliter seriata, carinato-concava, e basi ovata sensim anguste acuminata, circa 2 mm longa; marginibus erectis, apicem versus argute dentatis; costa breviter excurrente; cellulae superiores rotundatae, 8 ad 10 μ, papillosae, parietibus haud incrassatis, inferiores juxta-costales magnae, ovoidae, tuberculosae, infimae lineares, marginales anguste lineares, limbum latum 10 ad 12 seriatum formantes. Folia perichaetialia erecta, e basi lanceolata longe acuminata, ad 3.5 mm longa; seta circa 8 mm longa, rubra, ubique scabrata; theca elliptica, ore contracto, angulato; peristomium simplex, 50 ad 60 μ altum, dentibus inter se concretis, papillosis; spori variabiles ad 35 μ, papillosi.

BORNEO, Mount Kinabalu, Penibukan, elevation 4,000 feet, jungle, east ridge, on twigs of tree, *Clemens 40531* type; Penibukan, elevation 4,500 feet, jungle ridge above camp, on tree, *Clemens 50305a;* Masilan River, elevation 7,000 feet, on *Vernonia, Magnolia,* etc., *Clemens 51487b.*

If the affinities of this species are with *M. orthostichum* Nees, as seems probable, the differences are very marked; *M. Clemensiae* is a much coarser plant with finely acuminate leaves imbricated in spiral rows. The basal areolation is unique in having the coarsely tuberculate cells of the leaf base widely bordered on each side by a broad band of very narrow, incrassate smooth cells extending about one-fourth of the way up the margins.

MACROMITRIUM LONGICAULE C. M.

Pinokkok Falls, wet rocks, elevation 6,500 feet, *Clemens 50002a.*

MACROMITRIUM BLUMII Nees.

Penibukan, jungle ridge above camp, on tree trunk, elevation 4,500 feet, *Clemens 50305;* Penibukan, Pinokkok Falls, lobang, branches of tree, elevation 5,000 feet, *Clemens 40933.*

MACROMITRIUM OCHRACEUM (Doz. and Molk.) C. M.

Masilan River, elevation 5,000 feet, on tree over Lewago River, *Clemens 51484;* Masilan River, elevation 7,000 feet, on *Vernonia, Magnolia,* etc., *Clemens 51487.*

MACROMITRIUM OCHRACEOIDES Dix.

Gurulau Spur, above rise of Dahobang, on Myrtaceæ, elevation 12,500 feet, *Clemens 50998.*

SCHLOTHEIMIA WALLISI C. M.

Schlotheimia splendida Mitt.

Masilan River, elevation 7,000 feet, on *Vernonia, Magnolia,* etc., *Clemens 51487c.*

SCHLOTHEIMIA RUBIGINOSA C. H. Wright.

Gurulau Spur, above rise of Dahobang, on Myrtaceæ, elevation 12,500 feet, *Clemens 50998a.*

LEPTODONTIOPSIS ORIENTALIS Dix.

Gurulau Spur, elevation 12,000 to 13,000 feet, above Pinokkok River, granite dome, on rocks, *Clemens 51197;* Gurulau Spur, above rise of Dahobang, elevation 12,500 feet, *Clemens 50448b;* Gurulau Spur, base of Victoria Peak, elevation 12,500 feet, on granite slope.

No. *51197,* in particular, is abundant and in fine fruit. It is more robust than indicated by the description of the type collection with setæ up to 2.5 to 3 cm long, but is undoubtedly the same plant.

I willingly defer to Mr. Dixon's judgement in placing this species in *Leptodontiopsis.* It has close and natural affinities, however, with *Zygodon,* and especially with *Z. tetragonostomus* Al. Br., from which it is clearly separable by the dicœcious inflorescence, more strongly toothed leaf margins, large spores up to 30 to 35 μ, and the costa papillose on the back. These distinctions are of specific importance, but their value as generic indicators remains to be established.

RHACOPILACEÆ

RHACOPILUM SPECTABILE Reinw. and Hornsch.

Penibukan, near Pinokkok Falls, on log, elevation 6,000 feet, *Clemens 50131a;* headwaters of Columbon River, on rocks, elevation 4,500 feet.

HEDWIGIACEÆ

RHACOCARPUS ALPINUS (C. H. Wright) Par.

Masilan, elevation 7,000 feet, near ford, *Clemens 51654*.

CRYPHAEACEÆ

CRYPHAEA BORNEENSIS sp. nov.

Caules secundarii elongati, flexuosi, circa 10 cm longi, irregulariter pinnati, ramis patulis, obtusis. Folia caulina sicca laxe erecta, humida erecto-patentia, 2.6 mm longa, ovata, obtusa; marginibus planis, apicem versus minute dentatis; costa valida, infra apicem soluta; cellulae superiores rotundato-hexagonae, laevissimae, 7 ad 8 μ latae, haud incrassatae, inferiores juxta-costales lineares, marginales seriebus pluribus subquadratae; folia ramea minora. Perichaetium crassum, foliis e basi late convoluta, sensim in subulam denticulatam productis; theca immersa, turgide elliptica, deoperculata circa 1 mm longa; operculum breviter conico-rostratum; calyptra ubique scabra; peristomium duplex ut videtur, exostomii dentes anguste lanceolati, papillosi, endostomium hyalinum, imperfectum, processus 0; spori minute papillosi, 25 μ.

BORNEO, Mount Tibang, elevation 1,400 m, *Mjoberg s. n.*, November, 1925.

This genus has not been recorded from Borneo, or from Malaysia, as far as I know. The long flexuose stems and foliation are suggestive of *C. dilatata* H. f. and W. from New Zealand, but the leaves are sharply toothed above and the perichætial leaves distinctly serrulate on the margins and along the edges of the rigid aristate point. The inner peristome is very rudimentary and apparently consists of an imperfect, lightly papillose, hyaline membrane about 75 μ high and more or less adherent to the teeth.

PTEROBRYACEÆ

SYMPHYSODONTELLA LAXISSIMA Bartr. and Dix. sp. nov.

Mollissima, palide viridis, nitidula. Caules ad 12 cm longi, laxissime pinnati, ramis circa 1 cm longis, complanatis, apice saepe ramuli tenuissimi microphylli emittens. Folia patentia, ad 1.5 mm longa, ecostata, ovato-lanceolata, concava, longe et tenuiter acuminata, superne minute denticulata; cellulae omnes angustissime, longae, laevissimae, sigmoideae, infimae lutescentes, alares numerosae, laxae, hyalinae sed haud vesiculosae. Caetera ignota.

BORNEO, Mount Kinabalu, Gurulau Spur, jungle spur west of camp, twining on twigs, elevation 5,000 feet, *Clemens 50558a*.

A distinct species in the lax, pinnately branched stems in contrast to the rigid, dendroid habit of most of the group. The slender, microphyllous branches occur frequently and in some of the plants are quite conspicuous.

ENDOTRICHELLA ELEGANS (Doz. and Molk.) Fleisch.

Penibukan, elevation 3,500 feet, ridge below camp, on branch, *Clemens 50053*.

METEORIACEÆ

METEORIUM MIQUELIANUM (C. M.) Fleisch.

Masilan River, elevation 7,000 feet, *Clemens 51289a, 51487a*.

No. *51487a* is a remarkably robust form with crowded, short, turgid, golden yellow branches up to 5 to 6 mm wide with leaves.

PAPILLARIA FUSCESCENS (Hook.) Jaeg.

Tenompok, on dead log, elevation 5,000 feet.

FLORIBUNDARIA FLORIBUNDA (Doz. and Molk.) Fleisch.

Masilan River, elevation 7,000 feet, *Clemens 51281, 51487c*; Penibukan, ridge, wall by side of Pinokkok Falls, elevation 6,500 feet, *Clemens 40899b*.

FLORIBUNDARIA THUIDIOIDES Fleisch.

Penibukan, near Pinokkok Falls, elevation 6,500 feet, *Clemens 40973a*.

New to Borneo. Distribution: Java, Philippines.

AEROBRYOPSIS LONGISSIMA (Doz. and Molk.) Fleisch.

Mount Kinabalu, without further data.

AEROBRYIDIUM LONGICUSPIS Broth.

Tenompok, on dead log, elevation 5,000 feet.

NECKERACEÆ

HOMALIODENDRON FLABELLATUM (Dicks.) Fleisch.

Tenompok, elevation 5,000 feet, on dead log.

PINNATELLA MUCRONATA (Lac.) Fleisch.

Jungle ridge near Dahobang River, elevation 3,500 feet, *Clemens 40594a*.

HOOKERIACEÆ

ERIOPUS REMOTIFOLIUS C. M.

Tenompok, on dead log, elevation 5,000 feet.

CALLICOSTELLA PAPILLATA (Mont.) Jaeg.

Penibukan, on old dead log, elevation 3,500 feet, *Clemens 40581a.*

CALLICOSTELLA PRABAKTIANA (C. M.) Jaeg.

Near Tuaran, elevation 500 to 700 feet, on rock in stream between paddies, *Clemens 51298.*

ACTINODONTIUM RHAPHIDOSTEGIUM (C. M.).

Dahobang River, on rocks near jungle, elevation 3,500 feet, *Clemens 40490b.*

New to Borneo. Distribution: Java, Celebes.

THUIDIACEÆ

THUIDIUM TAMARISCELLUM (C. M.).

Masilan River, near lobang, elevation 6,000 feet, *Clemens 51283.*

New to Borneo. Distribution: Northern India, Tonkin, Java, Sumatra, Philippines.

THUIDIUM GLAUCINUM (Mitt.) Mitt.

Tenompok, on dead log, elevation 5,000 feet.

THUIDIUM GLAUCINOIDES Broth.

Jungle ridge near Dahobang River, elevation 3,500 feet, *Clemens 40594b.*

THUIDIUM CYMBIFOLIUM (Doz. and Molk.).

On rock near Dahobang Falls, elevation 4,500 feet, *Clemens 40289b.*

BRACHYTHECIACEÆ

BRACHYTHECIUM PLUMOSUM (Hedw.).

Penibukan, on rock near Dahobang Falls, elevation 4,500 feet, *Clemens 40289, 40290a;* Penibukan, base of wall north of Pinokkok Falls, on rocks, elevation 7,000 feet, *Clemens 40982;* Masilan River, elevation 6,000 feet, *Clemens 51380.*

ENTODONTACEÆ

ENTODON BANDONGIAE (C. M.) Jaeg.

Damp rocks.

New to Borneo. Distribution: Java, Sumatra, Celebes, Philippines, Formosa.

SEMATOPHYLLACEÆ

TRISMEGISTIA PANDURIFORMIS (C. H. Wright) Broth.

Tenompok, damp logs, elevation 5,000 feet; head of Columbon River, mossy forest, Keebamban River, elevation 5,000 to 6,000 feet.

TRISMEGISTIA RIGIDA (Hornsch. and Reinw.) Broth.

Numerous collections at altitudes between 3,500 and 8,000 feet.

MASTOPOMA UNCINIFOLIUM (Broth.) Card.

Numerous collections from trees, logs, and stones up to 9,000 feet.

RHAPHIDOSTICHUM PILIFERUM (Broth.) Broth.

Pinokkok Falls, elevation 6,500 feet, on wet rocks, *Clemens 5002.*

New to Borneo. Distribution: Philippines.

ACROPORIUM CONVOLUTUM Fleisch.

On stones and trees, mossy jungle below Gurulau Lobang, elevation 6,000 to 8,000 feet, *Clemens 51451a.*

ACROPORIUM TURGIDUM (Doz. and Molk.) Fleisch.

Gurulau Spur, near stream, on tree trunks, *Clemens 51099.*

ACROPORIUM MONOICUM Fleisch.

Tenompok, on log, elevation 5,000 feet.

ACROPORIUM DIMINUTUM (Brid.) Fleisch.

Mount Tibang, *E. Mjoberg s. n.*, November, 1925.

TRICHOSTELEUM BOSCHII (Doz. and Molk.) Jaeg.

Penibukan, below Dahobang Falls, elevation 4,500 feet, on twig, *Clemens 40291a;* Penibukan, near Pinokkok Falls, elevation 6,000 feet, *Clemens 40973a.*

TRICHOSTELEUM LEPTOCARPON (Schwaegr.) Fleisch.

Penibukan, side ridge, jungle, elevation 4,500 feet, *Clemens 40712.*

TRICHOSTELEUM LEPTOCARPON var. ALTEPAPILLOSUM Dix.

Gurulau Spur, elevation 7,000 to 8,000 feet, *Clemens 51436;* on stones and trees, mossy jungle below Gurulau Lobang, elevation 6,000 to 8,000 feet, *Clemens 51451.*

TRICHOSTELEUM HAMATUM (Doz. and Molk.) Jaeg.

Columbon River basin, on tree, elevation 4,500 feet; Penibukan Ridge, on forest tree, elevation 4,000 feet, *Clemens 40431a.*

TAXITHELIUM LINDBERGII Ren. and Card.

Penibukan, near Pinokkok Falls, elevation 6,500 feet, *Clemens 40973.*

TAXITHELIUM MAGNUM Fleisch.

Numerous collections from Tenompok, Penibukan, and Gurulau Spur, mostly on twigs and branches of trees.

These collections vary considerably in size but differ in no way that I can see from *T. magnum* as represented in my herbarium by a specimen from Java collected and determined by Fleischer. The leaves are slenderly acuminate, sharply serrate above, the papillæ, when visible, few and inconspicuous, and the setæ often up to 2 cm or more long. The epiphytic habit on twigs and leaves seems to be constant in this series.

TAXITHELIUM SUMATRANUM (Lac.) Broth.

Penibukan Ridge, elevation 4,000 feet, damp jungle, *Clemens 40511.*

TAXITHELIUM MICRO-SIMILANS Dix.

Tenompok, damp logs, elevation 5,000 feet; Columbon River basin, on trees, elevation 4,500 feet.

HYPNACEÆ

ECTROPOTHECIUM PLICATUM Bartr. and Dix. sp. nov.

Dioicum, robustum, flavescens, parum nitidum. Caules ad 10 cm longi, radiculosi, densissime pinnati, ramis inequalibus, ad 2 cm longis, haud complanatis. Folia rigida, patentia, leniter falcata, plicata, circa 1.3 mm longa, e basi concava ovata, acuminata, apice serrata; costa bina, breviusculis, male definita; cellulae angustissime, inferiores latiores, incrassatae, valde porosae, alares paucissime, hyalinae vel nullae. Folia perichaetialia sensim longe acuminata, argute denticulata; seta 3 ad 5 cm longa; theca magna, fusca, 2 ad 2.2 mm longa, pendula, e collo distincto oblongo-elliptica; operculum conico-rostratum; calyptra ignota.

BORNEO, Mount Kinabalu, Gurulau Spur, head of Pinokkok River, elevation 8,000 feet, on twigs, *Clemens 50872.*

This species is unusually well marked by the rigid, plicate leaves, especially when dry, and the long setæ. *Ectropothecium Dixoni* Fleisch. has the leaves slightly plicate but is a much softer plant with longer leaf points and a much smaller sporophyte.

ECTROPOTHECIUM INTORQUATUM (Doz. and Molk.) Jaeg.

Tenompok, damp logs, elevation 5,000 feet.

ECTROPOTHECIUM BUITENZORGII (Bel.) Jaeg.

Gurulau Spur, elevation 4,000 feet; Tenompok trail, on stumps, etc., *Clemens 51056,* Penibukan, Lobang 11, above Pinokkok River, elevation 5,500 feet, *Clemens 50132.*

ECTROPOTHECIUM MORITZII (C. M.) Jaeg.

Tenompok, elevation 5,000 feet.

ECTROPOTHECIUM CYPEROIDES (Hook.) Jaeg.

Masilan River, elevation 6,000 feet, *Clemens 51486a;* Penibukan, jungle ridge near Dahobang River, elevation 3,500 feet, *Clemens 40594c.*

VESICULARIA RETICULATA (Doz. and Molk.) Broth.

Dahobang River, elevation 3,500 feet, on rocks near jungle, *Clemens 40490.*

New to Borneo. Distribution: India, Singapore, Java, Sumatra, Celebes, Philippines.

ISOPTERYGIUM MINUTIRAMEUM (C. M.) Jaeg.

Gurulau Spur, jungle spur, on bark of large tree near camp, elevation 5,000 feet, *Clemens 50477.*

ISOPTERYGIUM ALBESCENS (Schwaegr.) Jaeg.

Tenompok, elevation 5,000 feet, on logs.

CTENIDIADELPHUS SPINULOSUS (Broth.) Fleisch.

Tenompok, elevation 5,000 feet, on logs.

HYLOCOMIACEÆ

MACROTHAMNIUM JAVENSE Fleisch.

Penibukan, on rocks near Dahobang Falls, elevation 4,500 feet, *Clemens 40289a;* Marai Parai above Kamburanga (open places), taken from *Blechnum fluviatile* Lowe, elevation 10,000 feet, *Clemens 33122 bis.*

POLYTRICHACEÆ

RHACELOPUS PILIFER Doz. and Molk.

Penibukan, elevation 3,500 feet, on stones in stream, *Clemens 40512.*

POGONATUM WALLISI (C. M.) Jaeg.

Masilan River, elevation 6,000 feet, *Clemens 51379.*

New to Borneo. Distribution: Philippines.

POGONATUM JUNGHUHNIANUM (Doz. nad Molk.) Lac.

Tenompok, damp places, elevation 5,000 feet; jungle trail below Gurulau Kamboranga, on trees, elevation 6,000 to 8,000 feet, *Clemens 51047.*

POGONATUM MACROPHYLLOIDES Broth.

Head of Columbon River, elevation 5,000 to 7,000 feet; Gurulau Spur, elevation 7,000 to 8,500 feet, on rocks and clay soil, *Clemens 50887, 51026, 51210.*

DAWSONIA ALTISSIMA Geh.

Head of Columbon River, elevation 5,000 to 7,000 feet.

DAWSONIA BREVIFOLIA Gepp.

Gurulau Spur, elevation 7,000 to 8,000 feet, terrestrial, mossy forest, wet, *Clemens 51032;* Gurulau Spur, Gurulau Kamboranga, elevation 7,000 to 9,000 feet, *Clemens 50786;* Gurulau Spur, northwestern base of Victoria Peak, elevation 12,500 feet, shady bank, edge of rivulet, *Clemens 51407.*

ILLUSTRATION

[Drawings by the author.]

PLATE 1

FIG. 1. *Philonotis imperfecta* Bartr.; *a*, plant, × 1¼; *b* and *c*, leaves, × 20; *d*, apex of leaf, × 160; *e*, upper leaf cells and margin, × 460; *f*, part of peristome from the inside, × 160; *g*, capsule, × 14.

2. *Macromitrium Clemensiae* Bartr.; *a*, plant, × 1¼; *b* and *c*, leaves, × 20; *d*, one side of leaf base, × 160; *e*, capsule, × 20.

3. *Symphysodontella laxissima* Bartr. and Dix.; *a*, plant, × 1¼; *b* and *c*, leaves, × 20.

4. *Cryphaea borneensis* Bartr.; *a*, plant, × 1¼; *b*, stem leaf, × 20; *c*, branch leaf, × 20; *d*, upper leaf cells and margin, × 460; *e*, capsule, × 20.

5. *Ectropothecium plicatum* Bartr. and Dix.; *a*, plant, × 1¼; *b* and *c*, leaves, × 20; *d*, perichætial leaf, × 20.

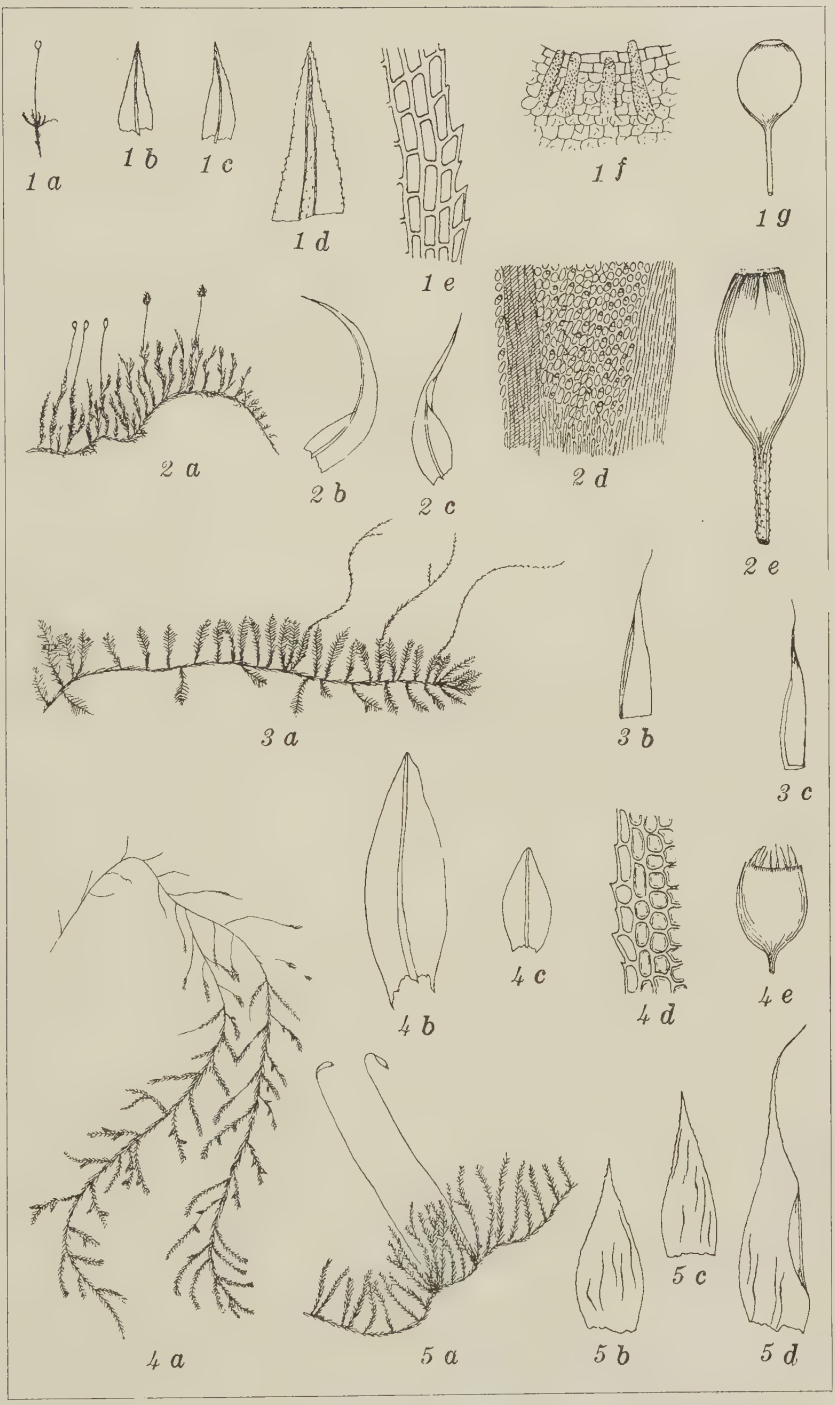


PLATE 1.

DIATOMS FROM BIWA LAKE, HONSHU ISLAND, NIPPON

By B. W. Skvortzow

Of Harbin, Manchoukuo

EIGHT PLATES

Several years ago Prof. Dr. Tamiji Kawamura, of Kyoto, sent me a tube of diatom clay from Biwa Lake, Nippon. Biwa Lake, one of the largest in Nippon, is north of Osaka, Honshu Island, in 35° 23′ north latitude. Its altitude is 86.3 meters, its area 644.8 square kilometers, and its maximum depth 95 meters.[1]

A careful examination of the diatom sample yielded more than two hundred forms of siliceous algæ. From systematic and geographic points of view the diatoms from Biwa Lake are of great interest. Some of these diatoms are essentially tropical, others are characteristic of alpine and Arctic regions. Among the species found in Biwa Lake, the following seem to inhabit warmer climates:

Melosira solida.
Melosira americana.
Melosira undulata.
Amphipleura pellucida v. *recta.*
Cymbella tumidula.
Neidium obliquestriatum.
Navicula Lambda.
Navicula Pusio.
Amphora delphinea var. *minor.*
Gomphonema Berggrenii.

The northern elements are widely represented in Biwa Lake by many large species of *Stauroneis, Navicula, Pinnularia, Gomphonema,* and *Cymbella. Didymosphenia geminata,* a common diatom in the northern part of Asia and of Europe, was also found. It was peculiar to find in Biwa Lake some species of American origin. *Melosira solida,* known from Arizona, was very abundant; *Stephanodiscus carconensis,* reported from Klamath Lake, Oregon, was represented by thousands of specimens. A distinct species, *Melosira americana,* known from tropical America, was also common in Biwa Lake. About eighty different diatoms known from Kizaki Lake were recovered in Biwa Lake. Several forms, of frequent occurrence in Kizaki Lake,

[1] Kindly reported by Dr. M. Ueno, of the Otsu Hydrobiological Station, Nippon.

were not found in the Kawamura gathering, which can scarcely be because my sample is not sufficiently large. Over seventy new species and varieties of algæ are described from Biwa Lake, and some are very distinct and peculiar.

From the ecological point of view the following diatoms from Biwa Lake are plankton species:

Melosira granulata and var.
Melosira solida.
Cyclotella comta and var.
Stephanodiscus carconensis.
Coscinodiscus lacustris var.
Attheya Zachariasi.
Chætoceros sp.
Asterionella gracillima.
Asterionella formosa.

The other diatoms belong to a bottom formation and include large forms; such as, *Melosira undulata, Opephora Martyi, Synedra Ulna* and var., and various species of *Eunotia, Cocconeis, Achnanthes, Navicula, Pinnularia, Cymbella, Gomphonema,* and *Surirella.* The last genus was very richly represented in the lake.

All of the diatoms listed in this note are fresh-water species, and only a few forms can be referred to brackish-water species; they are *Navicula crucicula* var., *Nitzschia tryblionella, N. Lorenziana,* and *N. Clausii.* This note is illustrated with drawings by the author, and they may be useful in future investigations.

MELOSIRA VARIANS C. A. Ag.

Melosira varians C. A. Ag., Fr. Hustedt, Bacillar. (1930) 85, fig. 41.

Frustule cylindrical, 0.08 mm broad. Rare. Reported from Aokiko and Kizaki Lakes.

MELOSIRA GRANULATA (Ehr.) Ralfs? var MUZZANENSIS (Meister) Bethge? Plate 1, fig. 20.

Melosira granulata (Ehr.) Ralfs? var. *muzzanensis* (Meister) Bethge? Fr. Hustedt, Kryptogam. Flora 7 Band, Kieselalgen (1927) 251, fig. 105.

Frustule cylindrical, 0.01 mm broad, 0.017 mm long. Striæ punctate, 13 in 0.01 mm, forming close longitudinal rows, 15 in 0.01 mm. Not common. Known from European lakes.

MELOSIRA GRANULATA (Ehr.) Ralfs var. ANGUSTISSIMA O. Müll. Plate 1, fig. 7.

Melosira granulata (Ehr.) Ralfs var. *angustissima* O. Müll., Fr. Hustedt, Kryptogam. Flora 7 Band, Kieselalgen (1927) 250, fig. 104*d*.

Frustule long, narrow, cylindrical, 0.027 mm long, 0.0034 broad. Puncta spiral. Uncommon in Biwa Lake. A pelagic species.

MELOSIRA SOLIDA Eulenstein. Plate 1, figs. 3 to 6, 10, 17, and 24.

Melosira solida Eulenstein, VAN HEURCK, Synopsis (1880–1881) pl. 86, figs. 36–39.

Frustule cylindrical, coarse, with thick siliceous margins. Length, 0.012 to 0.01 mm; breadth, 0.007 to 0.0085. Lateral horns massive, 0.0035 mm long. Striæ punctate, 12 in 0.01 mm, puncta 12 to 15 in 0.01 mm. Abundant in Biwa Lake. Known from Carcon, Arizona, and from Europe.

MELOSIRA SOLIDA Eulenstein var. NIPPONICA var. nov. Plate 1, figs. 1, 2, and 21.

Differs from the type in its puncta, disposed only in the middle part of the frustule. Opposite ends hyaline. Length, 0.025 mm; breadth, 0.006. Striæ 12 and puncta 12 in 0.01 mm. Common with the type species.

MELOSIRA AMERICANA Kütz. fo. NIPPONICA fo. nov. Plate 1, fig. 16.

Differs from the type in the presence of dots in the marginal sections of the frustule. Length and breadth about 0.0076 mm. The type is reported from tropical America and from Aokiko and Kizaki Lakes.

MELOSIRA UNDULATA (Ehr.) Kütz.

Melosira undulata (Ehr.) Kütz., A. SCHMIDT, Atlas Diatom. (1893) pl. 180, figs. 1–14, 16–19, 21.

Frustule cylindrical with thick margins. Length, 0.068 mm. Not common in Biwa Lake. Reported from the Tropics and as a fossil from Europe. Common in Aokiko and Kizaki Lakes.

MELOSIRA UNDULATA (Ehr.) Kütz. var NORMANNI Arnott.

Melosira undulata (Ehr.) Kütz. var. *Normanni* Arnott, VAN HEURCK, Synopsis (1880–1881) pl. 90, fig. 7.

Differs from the type in the polygonal shape of the inner part of the valve. Diameter of the frustules, 0.03 to 0.038 mm. A tropical diatom. Reported from Kizaki Lake.

CYCLOTELLA COMTA (Ehr.) Kütz.

Cyclotella comta (Ehr.) Kütz., FR. HUSTEDT, Bacillar. (1930) 103, fig. 69.

Valve circular, 0.01 to 0.015 mm in diameter. The marginal zone striated. Striæ 16 in 0.01 mm. Middle zone punctulate. Not common in Biwa Lake. Reported from Aokiko and Kizaki Lakes.

CYCLOTELLA COMTA (Ehr.) Kütz. var. OLYGACTIS (Ehr.) Grun. Plate 1, fig. 22.

Cyclotella comta (Ehr.) Kütz. var. *oligactis* (Ehr.) Grun., VAN HEURCK, Synopsis (1880–1881) pl. 93, figs. 18, 19.

Valve, 0.01 to 0.012 mm in diameter. Striæ 15 in 0.01 mm. The middle puncta coarse, arranged in radiate lines of unequal length. Rare, with the type. Known from Europe.

CYCLOTELLA GLOMERATA Bachmann fo. NIPPONICA Skvortzow. Plate 1, fig. 15.

Cyclotella glomerata Bachmann fo. *nipponica* SKVORTZOW, Diatom. Kizaki Lake (1936) pl. 1, fig. 12.

Valve very small, about 0.005 mm in diameter. Striæ fine, 18 in 0.01 mm. Common in Kizaki Lake.

STEPHANODISCUS CARCONENSIS Grun. Plate 1, figs. 19 and 23; Plate 6, fig. 2 (anomaly).

Stephanodiscus carconensis Grun., A. SCHMIDT, Atlas Diatom. (1901) pl. 228, figs. 9, 10.

Valve large, circular, with 24 to 36 radial marginal processes, 3 in 0.01 mm. Beads large, robust, radiately disposed, 15 to 18 in 0.01 mm. Diameter of the valves 0.025 to 0.045 mm. Abundant in Biwa Lake. Known from Klamath Lake, Oregon, and Shasta Country, California.

STEPHANODISCUS CARCONENSIS Grun. var. PUSILLA Grun. Plate 1, figs. 8, 9, 11 to 14, and 18.

Stephanodiscus carconensis Grun. var. *pusilla* Grun., A. SCHMIDT, Atlas Diatom. (1901) pl. 228, figs. 11, 12.

Valve minute, circular, strongly marked with coarse beads, becoming smaller only near the margin. Processes 6 to 13 radiate. Central area covered with beads. Margin distinct. Diameter of the valves 0.005 to 0.017 mm. Beads 15 in 0.01 mm. Common with the type.

STEPHANODISCUS BIWENSIS sp. nov. Plate 1, figs. 27 and 28.

Valve circular, strongly marked with coarse beads, irregularly in the center of the valve. The valve is ornamented with a corona of large spines on one-third of the valve border. Diameter of the valve 0.035 to 0.04 mm. Length of the spines 0.006 to 0.01 mm. Not common. The form most nearly resembling this species is *Stephanodiscus elegans* T. Brun, a fossil in Yedo, Nippon.

COSCINODISCUS LACUSTRIS Grun. var. NIPPONICA var. nov. Plate 1, fig. 26; Plate 6, fig. 1.

Valve circular, marked with longitudinal, radiate rows of puncta, forming in the center a hyaline space or corona of few puncta. Diameter, 0.05 to 0.06 mm. Puncta 10 in 0.01 mm. Not common in Biwa Lake. The type is known from fresh and brackish waters from large Eurasian lakes.

ATTHEYA ZACHARIASI Brun. Plate 5, fig. 15.

Attheya Zachariasi Brun, Fr. Hustedt, Bacillar. (1930) 118, fig. 99*c*.

This species is abundant in Biwa Lake, but found only as broken valves and endocysts. Length of endocysts, 0.028 to 0.034 mm; breadth, 0.0068 to 0.0085. Reported from Aokiko Lake. A pelagic species.

CHÆTOCEROS sp.

The broken valves and filaments of this diatom were common in the Biwa sample. They were poor for identification.

TABELLARIA FENESTRATA (Lyngb.) Kütz.

Tabellaria fenestrata (Lyngb.) Kütz., Fr. Hustedt, Bacillar. (1930) 122, fig. 99.

Valve linear, undulate in the middle part and at the ends. Length, 0.051 mm; breadth, 0.007. Common in fresh water. Uncommon in Biwa Lake. Reported from Kizaki Lake.

TABELLARIA FLOCCULOSA (Roth.) Kütz.

Tabellaria flocculosa (Roth.) Kütz., Fr. Hustedt, Bacillar. (1930) 123, fig. 101.

Valve small, undulate. Length, 0.025 mm; breadth, 0.007. Reported from Aokiko and Kizaki Lakes.

DIATOMA HIEMALE (Lyngb.) Heiberg var. MESODON (Ehr.) Grun.

Diatoma hiemale (Lyngb.) Heiberg var. *mesodon* (Ehr.) Grun., Fr. Hustedt, Bacillar. (1930) 129, fig. 116.

Valve oblong, lanceolate. Length, 0.017 mm; breadth, 0.007. Common in streams. Rare in Biwa Lake. Reported from Aokiko and Kizaki Lakes.

MERIDION CIRCULARE Agardh var. CONSTRICTA (Ralfs) Van Heurck.

Meridion circulare Agardh var. *constricta* (Ralfs) Van Heurck, Fr. Hustedt, Bacillar. (1930) 131, fig. 119.

Valve clavate and capitate. Length, 0.039 mm; breadth, 0.005. Rare. Reported from Kizaki Lake.

OPEPHORA MARTYI Herib.

Opephora Martyi Herib., Fr. Hustedt, Bacillar. (1930) 132, fig. 120.

Valve ovate, attenuate towards both ends. Length, 0.019 mm; breadth, 0.005. Striæ robust, 7 to 8 in 0.01 mm. Common. Known from the bottoms of large lakes. Reported from Aokiko and Kizaki Lakes.

FRAGILARIA CAPUCINA Desm.

Fragilaria capucina Desm., FR. HUSTEDT, Bacillar. (1930) 138, fig. 126.

Valve linear, almost parallel, with slightly attenuated and rounded ends. Length, 0.022 mm; breadth, 0.002. Striæ 18 in 0.01 mm. Common in fresh water. Known from Aokiko and Kizaki Lakes.

CERATONEIS ARCUS Kütz. var. HATTORIANA Meister.

Ceratoneis arcus Kütz. var. *Hattoriana* MEISTER, Beiträge zur Bacillariaceenflora Japans. 2 (1914) 226–227, pl. 8, figs. 1–3.

Valve linear-lanceolate, attenuate at the ends. Length, 0.034 mm; breadth, 0.005. Striæ 15 in 0.01 mm. Reported from Tokyo and Kizaki Lakes. Not common in Biwa Lake.

ASTERIONELLA GRACILLIMA (Hantzsch) Heiberg.

Asterionella gracillima (Hantzsch) Heiberg, FR. HUSTEDT, Bacillar. (1930) 147–148, fig. 157.

Valve linear with equally undulate ends. Length, 0.08 to 0.09 mm; breadth, 0.0017. Known from Kizaki Lake. A pelagic species.

ASTERIONELLA FORMOSA Hassall.

Asterionella formosa Hassall, FR. HUSTEDT, Bacillar. (1930) 147, fig. 156.

Valve linear, ends unequally undulate. Length, 0.075 mm; breadth, 0.0017. Known from Aokiko Lake. Not abundant in Biwa Lake.

SYNEDRA ULNA (Nitzsch) Ehr.

Synedra Ulna (Nitzsch) Ehr., FR. HUSTEDT, Bacillar. (1930) 151, figs. 158–159.

Valve linear, parallel, with attenuate ends. Length, 0.16 to 0.2 mm; breadth, 0.005 to 0.006. Striæ 9 in 0.01 mm. Not common. Reported from Aokiko and Kizaki Lakes.

SYNEDRA ULNA (Nitzsch) Ehr. var. RAMESI (Herib. and Peragallo) Hust. Plate 6, fig. 14.

Synedra Ulna (Nitzsch) Ehr. var. *Ramesi* (Herib. and Peragallo) Hust., HUSTEDT, Bacillar. (1930) 152, fig. 163.

Valves broad, short with abruptly acuminate ends. Length, 0.039 to 0.042 mm; breadth, 0.007 to 0.0085. Striæ 9 to 10 in 0.01 mm. Reported from Kizaki Lake.

SYNEDRA ULNA (Nitzsch) Ehr. var. DANICA (Kütz.) Grun.

Synedra Ulna (Nitzsch) Ehr. var. *danica* (Kütz.) Grun., Fr. Hustedt, Bacillar. (1930) 154, fig. 168.

Valve very long and narrow, regularly attenuate towards the ends. Ends capitate. Length, 0.217 mm; breadth, 0.0048 to 0.005. Striæ 9 in 0.01 mm. Reported from Kizaki Lake.

SYNEDRA ULNA (Nitzsch) Ehr. var. OXYRHYNCHUS (Kütz.) Van Heurck fo. CONSTRICTA Hustedt. Plate 2, fig. 16.

Synedra Ulna (Nitzsch) Ehr. var. *oxyrhynchus* (Kütz.) Van Heurck fo. *constricta* Hustedt, Bacillar. (1930) 152, fig. 161.

Valve linear, abruptly constricted in the middle. Ends acuminate. Length, 0.078 mm; breadth, 0.006. Striæ 9 in 0.01 mm. Not common.

SYNEDRA ULNA (Nitzsch) Ehr. var. AMPHIRHYNCHUS (Ehr.) Grun.

Synedra Ulna (Nitzsch) Ehr. var. *amphirhynchus* (Ehr.) Grun., Fr. Hustedt, Bacillar. (1930) 154, fig. 167.

Valve linear, attenuate and capitate. Length, 0.12 mm; breadth, 0.0068. Striæ 7 in 0.01 mm. Common in Biwa Lake.

SYNEDRA NANA Meister.

Synedra nana Meister, Fr. Hustedt, Bacillar. (1930) 158, fig. 183.

Valve very narrow-linear, gradually attenuate to the ends. Length, 0.044 mm; breadth, 0.002. Striæ fine, 24 in 0.01 mm. Reported from alpine lakes, Lago di Crocetto, Bernina, Davoser Lake, Europe.

SYNEDRA NANA Meister var. NIPPONICA Skvortzow. Plate 5, fig. 21.

Synedra nana Meister var. *nipponica* Skvortzow, Diatom. Kizaki Lake (1936) pl. 10, fig. 29.

Smaller than the type. Ends capitate. Length, 0.027 mm; breadth, 0.0012. Striæ 25 in 0.01 mm. Differs from the specimens from Kizaki Lake in the narrower valves and the number of striæ. Not common.

SYNEDRA RUMPENS Kütz. var. MENEGHINIANA Grun.

Synedra rumpens Kütz. var. *Meneghiniana* Grun., Fr. Hustedt, Bacillar. (1930) 156, fig. 178.

Valve linear-lanceolate with slightly capitate ends. Length, 0.027 mm; breadth, 0.0034. Striæ 12 in 0.01 mm. Reported from Kizaki Lake.

SYNEDRA RUMPENS Kütz. var. FRAGILARIOIDES Grun. fo. NIPPONICA fo. nov. Plate 3, fig. 7.

Differs from the type in its finer striæ. In the middle part the valve is undulate. Length, 0.018 mm; breadth, 0.0034. Striæ 15 in 0.01 mm, not punctate. Uncommon in Biwa Lake.

SYNEDRA VAUCHERIÆ Kütz. var. CAPITELLATA Grun.

Synedra Vaucheriæ Kütz. var. *capitellata* Grun., Fr. Hustedt, Bacillar. (1930) 161, fig. 194.

Valve linear-lanceolate with attenuate and capitate ends. Length, 0.015 mm; breadth, 0.0032. Striæ 18 in 0.01 mm. Reported from Kizaki Lake.

SYNEDRA MINUSCULA Grun. var. CAPITATA var. nov. Plate 1, fig. 25.

Differs from the type in its short capitate ends. Length, 0.02 mm; breadth, 0.003. Striæ 15 in 0.01 mm. Uncommon in Biwa Lake.

SYNEDRA PARASITICA W. Sm. Plate 2, fig. 21.

Fragilaria parasitica W. Sm., A. Schmidt, Atlas Diatom. (1913) pl. 296, figs. 79–80.

A distinct species with lanceolate valve, enlarged in the middle and attenuate towards the ends. Length, 0.024 mm; breadth, 0.0034. Striæ 18 in 0.01 mm. Common in Biwa Lake. Reported from Kizaki Lake.

SYNEDRA ACUS Kütz. Plate 2, fig. 4.

Synedra acus Kütz., A. Schmidt, Atlas Diatom. (1914) pl. 303, fig. 7.

Valve linear-lanceolate. Length, 0.09 mm; breadth, 0.005. Striæ 12 in 0.01 mm. Common in fresh water.

SYNEDRA NIPPONICA Skvortzow. Plate 4, fig. 13.

Synedra nipponica Skvortzow, Diatoms Kizaki Lake (1936) pl. 1, fig. 43.

Valve small, lanceolate, enlarged in the middle, gradually attenuate towards the ends. Length, 0.0085 mm; breadth, 0.0019. Striæ 24 in 0.01 mm. Differs from the Kizaki specimen in its coarser striæ.

EUNOTIA GRACILIS (Ehr.) Rabh. Plate 8, fig. 12.

Eunotia gracilis (Ehr.) Rabh., Fr. Hustedt, Bacillar. (1930) 185, fig. 253.

Valve linear, slightly curved, with parallel margins. Ends capitate. Length, 0.05 to 0.093 mm; breadth, 0.004 to 0.005. Striæ 10 in 0.01 mm. Reported from Kizaki Lake.

EUNOTIA PRÆRUPTA Ehr. var. BIDENS Grun. Plate 8, fig. 13.

Eunotia prærupta Ehr. var. *bidens* Grun., Fr. Hustedt, Bacillar. (1930) 174, fig. 213.

Valve robust, genuflexed, biundulate with rostrate and truncate ends. Length, 0.083 mm; breadth, 0.013. Striæ 8 in 0.01 mm. Not common.

EUNOTIA PECTINALIS (Kütz.) Rabh. var. MINOR (Kütz.) Rabh.

Eunotia pectinalis (Kütz.) Rabh. var. *minor* (Kütz.) Rabh., Fr. Hustedt, Bacillar. (1930) 182, fig. 238.

Valve linear, genuflexed, slightly gibbous in the middle, with short attenuate ends. Length, 0.034 mm; breadth, 0.0042. Striæ 14 in 0.01 mm. Reported from Kizaki Lake.

EUNOTIA PECTINALIS (Kütz.) Rabh. var. MINOR (Kütz.) Rabh. fo. IMPRESSA (Ehr.).

Eunotia pectinalis (Kütz.) Rabh. var. *minor* (Kütz.) Rabh. fo. *impressa* (Hustedt), Bacillar. (1930) 182, fig. 239.

Valve reflexed. Length, 0.027 mm; breadth, 0.0065. Striæ 15 in 0.01 mm. Known from Aokiko Lake.

EUNOTIA SUDETICA (O. Müll.) Hust. var. NIPPONICA var. nov. Plate 2, fig. 15.

Valve genuflexed, gradually attenuate towards the ends. Ends slightly capitate, broad, rounded. Length, 0.037 mm; breadth, 0.005. Striæ 6 in 0.01 mm. Differs from the type in its more elongate valves and wider striæ. Uncommon.

EUNOTIA VENERIS (Kütz.) O. Müll.

Eunotia veneris (Kütz.) O. Müll., Fr. Hustedt, Bacillar. (1930) 182–183, fig. 245.

Valve linear, straight on the ventral side, reflexed at the dorsal side. Ends acute. Length, 0.0187 mm; breadth, 0.004. Striæ 15 in 0.01 mm. Uncommon.

EUNOTIA LUNARIS (Ehr.) Grun.

Eunotia lunaris (Ehr.) Grun., Fr. Hustedt, Bacillar. (1930) 183–184, fig. 249.

Valve linear, lunate with parallel margins and rounded ends. Length, 0.052 mm; breadth, 0.004. Striæ 15 in 0.01 mm. Reported from Kizaki Lake.

ACTINELLA BRASILIENSIS Grun.

Actinella brasiliensis Grun., Skvortzow, Diatoms Kizaki Lake (1936) pl. 8, fig. 11.

Valve linear, clavate, broad-capitate and apiculate at the apex, regularly attenuate towards the end. Length, 0.08 to 0.09 mm.

Not common. Reported from Kizaki Lake, Chosen, and Hanka Lake.

COCCONEIS PLACENTULA (Ehr.).

Cocconeis placentula (Ehr.) FR. HUSTEDT, Bacillar. (1930) 189, fig. 260.

Valve elliptical. Length, 0.04 mm; breadth, 0.025. Uncommon. Reported from Aokiko Lake.

COCCONEIS PLACENTULA (Ehr.) var. EUGLYPTA (Ehr.) Cleve.

Cocconeis placentula (Ehr.) var. *euglypta* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 190, fig. 261.

Differs from the type in its fine, longitudinal, undulating, blank bands. Length, 0.0085 mm; breadth, 0.0068. Uncommon in Biwa Lake. A fresh-water diatom.

COCCONEIS PLACENTULA (Ehr.) var. LINEATA (Ehr.) Cleve.

Cocconeis placentula (Ehr.) var. *lineata* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 190, fig. 262.

Valve elliptical, crossed by fine, longitudinal, undulating, blank bands. Length, 0.024 mm; breadth, 0.014. Reported from Kizaki Lake.

COCCONEIS DISCULUS Schum. var. NIPPONICA var. nov. Plate 4, fig. 16.

Broader and smaller than the type form. Length, 0.014 mm; breadth, 0.01. Striæ 10 in 0.01 mm. *Cocconeis disculus* is known from bottoms of European lakes.

COCCONIES DIMINUTA Pant.

Cocconeis diminuta Pant., FR. HUSTEDT, Bacillar. (1930) 191–192, fig. 265.

Valve elliptical. Length, 0.01 mm; breadth, 0.0085. Lower valve with very fine striæ, upper valve with more-robust striation. Striæ 18 in 0.01 mm. Reported from Aokiko and Kizaki Lakes. Known from European lakes.

EUCOCCONEIS ONEGENSIS Wisl. and Kolbe. Plate 6, figs. 4 and 5.

Eucocconeis onegensis WISLOUCH and KOLBE, New diatoms from Russia (1916) Journ. Microbiol. 3: 169–271, pl. 3, figs. 5, 6; Beiträge zur Diatomeenflora des Onego-Sees (1927) 33, 72, pl. figs. 2, 3.

Valve robust, lanceolate, broad-undulate at the middle, gradually attenuate towards the ends. Length, 0.03 mm; breadth, 0.015. Upper valve with radiate striæ. Central area oblique, rectangular from one side, dilated on the other side. Axial area narrow, filiform. Lower valve rectangular, with a broad stauros, widened and truncate outwards. Striæ punctate, 18 in

0.01 mm. Uncommon. Known from Onega Lake, northern Europe, Russia.

ACHNANTHES MINUTISSIMA Kütz.

Achnanthes minutissima Kütz., Fr. Hustedt, Bacillar. (1930) 198, fig. 274.

Valve linear-elliptical, attenuate towards the ends. Length, 0.013 mm; breadth, 0.002. Striæ 30 in 0.01 mm. Reported from Kizaki Lake. Common in Biwa Lake.

ACHNANTHES HAUCKIANA Grun. var. NIPPONICA var. nov. Plate 6, fig. 12.

Differs from the type in its rounded ends and slightly undulated middle part. Length, 0.011 mm; breadth, 0.003. Striæ 12 in 0.01 mm, more distinct in the middle part of the valve. Uncommon.

ACHNANTHES CLEVEI Grun. Plate 2, fig. 3.

Achnanthes Clevei Grun., Fr. Hustedt, Bacillar. (1930) 203, fig. 294.

Valve elliptical-lanceolate with attenuate ends. Length, 0.012 mm; breadth, 0.0058. Upper valve with a narrow, linear, axial area, with robust striæ, 12 in 0.01 mm. Lower valve with outward-dilated central area. Striæ radiate, punctate, 24 in 0.01 mm, in the middle of unequal length. Common. Reported from Aokiko Lake.

ACHNANTHES CLEVEI Grun. var. NIPPONICA Skvortzow. Plate 5, fig. 5.

Achnanthes Clevei Grun. var. *nipponica* Skvortzow, Diatoms Kizaki Lake (1936) pl. 2, fig. 24.

Valve long-elliptical with attenuate ends. Length, 0.027 mm; breadth, 0.0068. Striæ of the upper valve 9, of the lower valve 21, in 0.027 mm. Known from Kizaki Lake.

ACHNANTHES PINNATA Hust. var. JAPONICA Hustedt.

Achnanthes pinnata Hust. var. *japonica* Hustedt, Bacillar. aus dem Aokikosee in Japan 161, pl. 5, figs. 12, 13.

Valve minute, ovate with rounded ends. Length, 0.005 mm; breadth, 0.0027. Striæ 22 in 0.01 mm. Reported from Aokiko and Kizaki Lakes. The type is known from central Asia.

ACHNANTHES PERAGALLII Brun and Heribaud.

Achnanthes Peragallii Brun and Heribaud, Fr. Hustedt, Bacillar. (1930) 207, fig. 300.

Valve lanceolate with abruptly attenuate and capitate ends. Length, 0.01 mm; breadth, 0.006. Reported from Aokiko and Kizaki Lakes.

ACHNANTHES LINEARIS W. Smith fo. MINUTA fo. nov.

Differs from the type in its smaller size. Valve linear-elliptical, slightly siliceous. Length, 0.0068 mm; breadth, 0.002. The type was reported from Aokiko and Kizaki Lakes.

ACHNANTHES AFFINIS Grun. Plate 5, fig. 18.

Achnanthes affinis Grun., FR. HUSTEDT, Bacillar. (1930) 199, fig. 282.

Valve linear-lanceolate, enlarged in the middle part, attenuate and capitate. Length, 0.012 mm; breadth, 0.0025. Striæ very fine, 30 in 0.01 mm. Uncommon.

ACHNANTHES BIASOLETTIANA Kütz. Plate 5, fig. 14.

Achnanthes Biasolettiana Kütz., FR. HUSTEDT, Bacillar. (1930) 199, fig. 289.

Valve broad linear-elliptical, undulate in the middle, broadly rounded at the ends. Length, 0.012 mm; breadth, 0.0053. Striæ very fine, 30 in 0.01 mm. Uncommon.

ACHNANTHES LANCEOLATA Breb.

Achnanthes lanceolata Breb., FR. HUSTEDT, Bacillar. (1930) 207, fig. 306*a*.

Valve lanceolate-elliptical with broad ends. Length, 0.012 mm; breadth, 0.005. Striæ 15 in 0.01 mm. Reported from Aokiko and Kizaki Lakes. Common in Biwa Lake.

ACHNANTHES LANCEOLATA Breb. var. ROSTRATA Hust.

Achnanthes lanceolata Breb. var. *rostrata* HUSTEDT, Bacillar. (1930) 208, fig. 306*b*.

Valve with rostrate ends. Length, 0.009 mm; breadth, 0.005. Striæ 12 in 0.01 mm. Reported from Kizaki Lake.

ACHANANTHES LANCEOLATA Breb. var. ELLIPTICA Cleve.

Achnanthes lanceolata Breb. var. *elliptica* Cleve, FR. HUSTEDT, Bacillar. (1930) 208, fig. 306*c*.

Valve broad-elliptical. Length, 0.015 mm; breadth, 0.0068. Known from Kizaki Lake.

ACHNANTHES LANCEOLATA Breb. var. NIPPONICA Skvortzow.

Achnanthes lanceolata Breb. var. *nipponica* SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 12, fig. 13.

Valve broad-lanceolate, slightly gibbous in the middle, obtuse. Length, 0.015 mm; breadth, 0.065. Striæ 12 in 0.01 mm. Differs from the type in its short valves. Common in Biwa Lake. Reported from Kizaki Lake.

ACHNANTHES EXIGUA Grun. var. INDICA Skvortzow.

Achnanthes exigua Grun. var. *indica* SKVORTZOW, Diatoms from Calcutta (1935) pl. 1, fig. 3.

Valve slightly siliceous, short. Length, 0.0076 mm; breadth, 0.0042. Reported from Calcutta and Kizaki Lake.

RHOICOSPHENIA CURVATA (Kütz.) Grun. Plate 2, fig. 14.

Rhoicosphenia curvata (Kütz.) Grun., FR. HUSTEDT, Bacillar. (1930) 211, fig. 311.

Valve linear, clavate, attenuate towards the ends. Length, 0.042 mm; breadth, 0.0068. Striæ 12 in 0.01 mm. Known from Aokiko and Kizaki Lakes.

RHOICOSPHENIA CURVATA (Kütz.) Grun. var. MAJOR Cleve. Plate 7, fig. 2.

Rhoicosphenia curvata (Kütz.) Grun. var. *major* CLEVE, Synopsis Navicul. Diatoms 2 (1895) 165.

Larger than the type. Length, 0.078 mm; breadth, 0.0085. Striæ 11 in 0.01 mm. Known from Pitt River, Oregon, North America. Not common in Biwa Lake.

AMPHIPLEURA PELLUCIDA Kütz. var. RECTA Kitton.

Amphipleura pellucida Kütz. var. *recta* Kitton, P. CLEVE, Synopsis Navicul. Diatoms (1894) 1, 127; SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 3, fig. 6.

Valve linear with gently cuneate ends. Length, 0.25 mm; breadth, 0.017. Known from Kizaki Lake, Nippon, and from southern China. Found by Kitton in stomachs of Nipponese oysters. A fresh-water species.

FRUSTULIA RHOMBOIDES (Ehr.) de Toni var. SAXONICA (Rabh.) de Toni fo. NIPPONICA fo. nov. Plate 4, fig. 14.

Valve elliptical, attenuate. Length, 0.034 mm; breadth, 0.011. Differs from the type in its broader valves. Not common.

FRUSTULIA RHOMBOIDES (Ehr.) de Toni var. AMPHIPLEUROIDES Grun.

Frustulia rhomboides (Ehr.) de Toni var. *amphipleuroides* Grun., FR. HUSTEDT, Bacillar. (1930) 221, fig. 326.

Valve lanceolate, narrow. Length, 0.105 mm; breadth, 0.019. Reported from Aokiko and Kizaki Lakes.

FRUSTULIA VULGARIS Thwait. var. ASIATICA Skvortzow. Plate 6, fig. 6.

Frustulia vulgaris Thwait. var. *asiatica* SKVORTZOW, Diatoms from N. Manchuria (1928) 42, pl. 2, fig. 12.

Valve linear-lanceolate with obtuse, truncate, and broad ends. Length, 0.044 mm; breadth, 0.008. Reported from Manchuria and Ceylon.

GYROSIGMA KUTZINGII (Grun.) Cleve.

Gyrosigma Kutzingii (Grun.) Cleve, FR. HUSTEDT, Bacillar. (1930) 224, fig. 333.

Valve sigmoid, gradually attenuate towards the ends. Length, 0.105 mm; breadth, 0.0013. Longitudinal striæ 21, transverse striæ 26, in 0.01 mm. Reported from Aokiko and Kizaki Lakes.

GYROSIGMA ACUMINATUM (Kütz.) Rabh.

Gyrosigma acuminatum (Kütz.) Rabh., FR. HUSTEDT, Bacillar. (1930) 222, fig. 329.

Valve large and robust. Length, 0.184 mm; breadth, 0.02. Longitudinal and transverse striæ 18 in 0.01 mm. Known from Kizaki Lake.

GYROSIGMA SPENCERII (W. Smith) Cleve var. NODIFERA Grun. Plate 3, fig. 4.

Gyrosigma Spencerii (W. Smith) Cleve var. *nodifera* Grun., FR. HUSTEDT, Bacillar. (1930) 226, fig. 337.

Valve robust, broad, with rounded, oblique ends. Length, 0.122 mm; breadth, 0.017. Longitudinal striæ 24, transverse 22 to 24, in 0.01 mm. The transverse striæ in the middle part of the valve radiate. Not common. Known from fresh waters.

GYROSIGMA ATTENUATUM (Kütz.) Rabh. var. NIPPONICA var. nov. Plate 7, fig. 1.

Valve broad-linear, slightly sigmoid with attenuate ends. Length, 0.158 to 0.16 mm; breadth, 0.0187 to 0.0192. Longitudinal striæ narrow, 21 to 24 in 0.01 mm, in the middle part radiate. Central area oblique, terminal area distinct, obliquely enlarged. Seems to be a distinct species. Not common. Differs from the type in having coarser transverse striæ.

CALONEIS BACILLUM (Grun.) Meresch.

Caloneis bacillum (Grun.) Meresch., FR. HUSTEDT, Bacillar. (1930) 236, fig. 360*a*.

Valve linear or linear-lanceolate with parallel margins and rounded ends. Length, 0.037 mm; breadth, 0.007. Striæ 18 in 0.01 mm. Uncommon.

CALONEIS BACILLUM (Grun.) Meresch. var. LANCETTULA (Schulz.) Hustedt. Plate 2, fig. 9.

Caloneis bacillum (Grun.) Meresch. var. *lancettula* (Schulz.) HUSTEDT, Bacillar. (1930) 236, fig. 361.

Valve lanceolate. Length, 0.018 to 0.034 mm; breadth, 0.004 to 0.0085. Striæ 24 to 26 in 0.01 mm. Reported from Aokiko Lake.

CALONEIS BACILLUM (Grun.) Meresch. var. LANCETTULA (Schulz.) Hust. fo. DENSISTRIATA fo. nov. Plate 7, fig. 11.

Valve lanceolate with attenuate ends. Length, 0.034 mm; breadth, 0.0085. Striæ very fine, about 35 to 40 in 0.01 mm. Differs from variety *lancettula* in its fine striæ. Not common.

CALONEIS SILICULA (Ehr.) Cleve var. TUMIDA Hust.

Caloneis silicula (Ehr.) Cleve var. *tumida* HUSTEDT, Bacillar. (1930) 218, fig. 367.

Valve robust, undulate with attenuate ends. Length, 0.072 to 0.09 mm; breadth, 0.013 to 0.015. Reported from Kizaki Lake.

CALONEIS SILICULA Ehr. var. BAICALENSIS Skv. and Mayer. Plate 6, fig. 9.

Caloneis silicula Ehr. var. *baicalensis* SKVORTZOW and MAYER, Contribut. Diatom. of Baikal Lake (1928) 12, pl. 1, fig. 44.

Valve linear-triundulate. Length, 0.04 to 0.052 mm; breadth, 0.0068 to 0.0076. Striæ 20 to 24 in 0.01 mm. Differs from variety *Kjellmaniana* Grun. in its coarser striæ. Reported from Kizaki Lake.

CALONEIS SILICULA (Ehr.) Cleve var. TRUNCATULA Grun.

Caloneis silicula (Ehr.) Cleve var. *truncatula* Grun., FR. HUSTEDT, Bacillar. (1930) 238, fig. 364*b*.

Valve linear, slightly attenuate with broad rounded ends. Length, 0.045 mm; breadth, 0.01. Reported from Kizaki Lake.

CALONEIS PUNCTATA sp. nov. Plate 3, fig. 18.

Valve broad, linear-elliptical with broad ends and enlarged middle part. Length, 0.018 mm; breadth, 0.006. Striæ punctate, almost parallel, 15 in 0.01 mm. Puncta about 25 to 30 in 0.01 mm. Axial and central areas very narrow. Median line straight. Uncommon. A form akin to *Caloneis Zachariasi* Reichelt.

CALONEIS NIPPONICA sp. nov. Plate 2, fig. 7; Plate 3, fig. 9; Plate 4, fig. 15.

Valve linear-biundulate with broadly truncate and rounded ends. Length, 0.042 to 0.06 mm; breadth, 0.007 to 0.01. Central area a broad stauros. Striæ radiate, 17 to 18 in 0.01 mm. Median line straight, axial area linear and slightly enlarged. This new species is akin to *Caloneis columbiensis* Cleve, found in Columbia River, Oregon, and to the marine diatom *C. clavigera* Cleve. Common in Biwa Lake.

NEIDIUM DUBIUM (Ehr.) Cleve fo. CONSTRICTA Hustedt. Plate 3, fig. 15.

Neidium dubium (Ehr.) Cleve fo. *constricta* HUSTEDT, Bacillar. (1930) 246, fig. 384*b*.

Valve linear, minute. Length, 0.037 mm; breadth, 0.01. Striæ very fine, 24 to 28 in 0.01 mm. Common.

NEIDIUM HITCHCOCKII Ehr.

Neidium Hitchcockii Ehr., A. SCHMIDT, Atlas Diatom. (1877) pl. 49, figs. 35, 36.

Valve triundulate. Length, 0.051 mm; breadth, 0.013. Common. Reported from Aokiko and Kizaki Lakes.

NEIDIUM IRIDIS (Ehr.) Cleve.

Neidium iridis (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 245, fig. 379.

Valve linear-lanceolate, attenuate towards the ends. Length, 0.049 to 0.01 mm; breadth, 0.018 to 0.025. Striæ 15 to 20 in 0.01 mm. Uncommon in Biwa Lake. Known from Aokiko Lake.

NEIDIUM OBLIQUESTRIATUM A. S. Plate 2, fig. 12.

Neidium obliquestriatum A. Smith, A. SCHMIDT, Atlas Diatom. (1877) pl. 49, figs. 41, 42.

Valve triundulate with truncate ends. Length, 0.068 to 0.0153 mm; breadth, 0.012 to 0.025. Striæ oblique, 18 to 24 in 0.01 mm. Median line straight, axial area linear. Uncommon in Biwa Lake. Reported from Demerara River, Brazil, and from Aokiko Lake, Nippon.

NEIDIUM OBLIQUESTRIATUM A. S. var. NIPPONICA Skvortzow.

Neidium obliquestriatum A. S. var. *nipponica* SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 4, fig. 22.

Valve lanceolate with attenuate ends. Length, 0.068 mm; breadth, 0.017. Striæ oblique, 21 in 0.01 mm. Common. Reported from Kizaki Lake.

NEIDIUM OBLIQUESTRIATUM A. S. var. ELONGATA var. nov. Plate 8, fig. 1.

Valve linear-lanceolate or linear-elliptical, gradually attenuate to the ends. Length, 0.085 mm; breadth, 0.015. Striæ oblique, 21 to 24 in 0.01 mm. Central area broad, oblique. Differs from the type in its elongate, not triundulate, valves. Common.

DIPLONEIS OVALIS (Hilse) Cleve.

Diploneis ovalis (Hilse) Cleve, FR. HUSTEDT, Bacillar. (1930) 249, fig. 390.

Valve broad-elliptical with rounded ends. Length, 0.042 mm; breadth, 0.023. Central area broad. Striæ radiate, 10 in 0.01

mm. Puncta 12 in 0.01 mm. Not common. Reported from Aokiko and Kizaki Lakes.

DIPLONEIS OVALIS (Hilse) Cleve var. OBLONGELLA (Naegeli) Cleve. Plate 5, fig. 19.

Diploneis ovalis (Hilse) Cleve var. *oblongella* (Naegeli) Cleve, Fr. Hustedt, Bacillar. (1930) 249, fig. 391.

Valve linear with rounded ends. Length, 0.046 to 0.091 mm; breadth, 0.017 to 0.027. Striæ radiate, 8 to 9 in 0.01 mm. Puncta 15 in 0.01 mm. Reported from Aokiko and Kizaki Lakes. Common in Biwa Lake.

DIPLONEIS OVALIS (Hilse) Cleve var. OBLONGELLA (Naegeli) Cleve fo. NIPPONICA fo. nov. Plate 2, fig. 23.

Valve small, elliptical. Length, 0.02 mm; breadth, 0.0085. Striæ 8 in 0.01 mm. Puncta very fine. Differs from the type in its short valve. Not common.

DIPLONEIS OVALIS (Hilse) Cleve var. BIPUNCTATA var. nov. Plate 3, fig. 1.

Valve broad-elliptical, undulate, attenuate towards the ends. Length, 0.03 mm; breadth, 0.02. Striæ bipunctate, 8 to 9 in 0.01 mm. Differs from the type in its bipunctate striæ. Common. Reported by F. Hustedt from Aokiko Lake and related to *Diploneis ovalis*.

DIPLONEIS OVALIS (Hilse) Cleve var. NIPPONICA var. nov. Plate 4, fig. 11.

Valve elliptical with attenuate ends. Length, 0.076 mm; breadth, 0.028. Striæ 8 in 0.01 mm. Puncta 15 in 0.01 mm. Differs from variety *oblongella* in its elliptical valve. Uncommon.

DIPLONEIS SMITHII (Breb.) Cleve var. NIPPONICA Skvortzow.

Diploneis Smithii (Breb.) Cleve var. *nipponica* Skvortzow, Diatoms Kizaki Lake (1936) pl. 2, figs. 1, 9.

Valve elliptical. Length, 0.06 to 0.085 mm; breadth, 0.03 to 0.04. Differs from the type in its more elongate and attenuate ends. Known from Kizaki Lake.

DIPLONEIS MARGINESTRIATA Hustedt var. NIPPONICA var. nov. Plate 4, fig. 3.

Valve linear-elliptical with broad, rounded ends. Length, 0.039 mm; breadth, 0.0136. Striæ 17 in 0.01 mm. Central area rectangular. Differs from the type in its striæ, from axial area to the margin, being without interruption. The type species is reported from Aokiko Lake.

DIPLONEIS PUELLA (Schum.) Cleve.

Diploneis puella (Schum.) Cleve, Fr. Hustedt, Bacillar. (1930) 250, fig. 394.

Valve elliptical, small, with broad ends. Length, 0.02 mm; breadth, 0.01. Striæ radiate, 10 in 0.01 mm. Common. Reported from Kizaki Lake.

STAURONEIS ANCEPS Ehr. var. SIBIRICA Grun.

Stauroneis anceps Ehr. var. *sibirica* Grun., Cleve and Grunow, Arctische Diatomeen (1880) pl. 3, fig. 65.

Valve linear-lanceolate with gradually attenuated ends. Length, 0.051 mm; breadth, 0.013. Central area a broad stauros widened and truncate outwards. Rare.

STAURONEIS ANCEPS Ehr. var. HYALINA Brun and Peragallo.

Stauroneis anceps Ehr. var. *hyalina* Brun and Peragallo, Fr. Hustedt, *Bacillar.* (1930) 256, fig. 408.

Valve lanceolate with long-acuminate ends. Length, 0.054 mm; breadth, 0.01. Striæ very fine, about 30 in 0.01 mm. Uncommon.

STAURONEIS PHŒNICENTERON Ehr.

Stauroneis phœnicenteron Ehr., Fr. Hustedt, Bacillar. (1930) 255, fig. 404.

Valve lanceolate with obtuse ends. Length, 0.095 mm; breadth, 0.017. Striæ radiate, 18 in 0.01 mm. Common. Reported from Aokiko and Kizaki Lakes.

STAURONEIS SMITHII Grun. var. RHOMBICA Meister. Plate 5, fig. 7.

Stauroneis Smithii Grun. var. *rhombica* Meister, Beiträge zur Bacillar. Japans. (1930) 228, pl. 8, fig. 5.

Valve rhombic-lanceolate, reflexed in the middle part. Length, 0.013 mm; breadth, 0.005. Striæ 25 in 0.01 mm. Our specimens are smaller than the type from Tokyo.

STAURONEIS SMITHII Grun. var. INCISA Pant.

Stauroneis Smithii Grun. var. *incisa* Pant., Fr. Hustedt, Bacillar. (1930), 261, fig. 421.

Valve lanceolate-elliptical. Margins not undulate. Length, 0.032 mm; breadth, 0.0068. Reported from Kizaki Lake.

NAVICULA MUTICA Kütz. var. NIPPONICA var. nov. Plate 4, fig. 10.

Valve elliptical with broad ends. Length, 0.032 mm; breadth. 0.01. Striæ 18 in 0.01 mm. Puncta 20 in 0.01 mm. Differs from the type in its broad valve and cuneate ends. Uncommon.

NAVICULA PUPULA Kütz. var. CAPITATA Hustedt.

Navicula pupula Kütz. var. *capitata* HUSTEDT, Bacillar. (1930) 281, fig. 467*c*.

Valve linear, slightly undulate, at the ends capitate. Length, 0.039 mm; breadth, 0.009. Reported from Kizaki Lake.

NAVICULA PUPULA Kütz. var. RECTANGULARIS (Greg.) Grun.

Navicula pupula Kütz. var. *rectangularis* (Greg.) Grun., FR. HUSTEDT, Bacillar. (1930) 281, fig. 467*b*.

Valve linear-rectangular, ends broad. Length, 0.059 mm; breadth, 0.012. Common. Reported from Kizaki Lake.

NAVICULA LAMBDA Cleve var. NIPPONICA var. nov. Plate 6, fig. 15.

Valve linear with parallel margins, broad with obtuse ends. Length, 0.044 to 0.068 mm; breadth, 0.01 to 0.014. Median line in a thick siliceous rib. Central area broad. Striæ radiate, 12 to 13 in the middle, 15 to 18 at the ends, in 0.01 mm. The type has constricted valves and is known from Demerara River, South America.

NAVICULA SUBHAMULATA Grun. Plate 2, fig. 10.

Navicula subhamulata Grun., FR. HUSTEDT, Bacillar. (1930) 282, fig. 468*a*.

Valve linear-elliptical with broad rounded ends. Length, 0.012 mm; breadth, 0.005. Striæ slightly radiate, 25 in 0.01 mm. Axial area very narrow. Median line curved at the ends. Not common. A fresh-water species.

NAVICULA SUBHAMULATA Grun. var. PARALLELA var. nov. Plate 5, fig. 11.

Valve broad-linear with parallel margins and broad, rounded, and obtuse ends. Length, 0.017 mm; breadth, 0.005. Striæ 18 to 20 in 0.01 mm. Median line straight. Axial area narrow. Differs from variety *undulata* Hust. in its parallel margins and wider striæ. Uncommon.

NAVICULA CRUCICULA (W. Smith) Donkin var. OBTUSATA Grun. Plate 8, fig. 9.

Navicula crucicula (W. Smith) Donkin var. *obtusata* Grun., FR. HUSTEDT, Bacillar. (1930) 284.

Valve broad-lanceolate with slightly attenuate ends. Length, 0.027 mm; breadth, 0.01. Striæ radiate, 24 in the middle, 30 at the ends, in 0.01 mm. Axial area narrow, central area somewhat dilated in the middle part. Uncommon. A brackish-water diatom.

NAVICULA ATOMUS (Naegeli) Grun.

Navicula atomus (Naegeli) Grun., Fr. Hustedt, Bacillar. (1930) 288, fig. 484.

Valve elliptical with rounded ends. Length, 0.0085 mm; breadth, 0.0042. Striæ 25 in 0.01 mm. Common in fresh water.

NAVICULA PSEUDOSCUTIFORMIS Hust.

Navicula pseudoscutiformis Hustedt, Bacillar. (1930) 291, fig. 495.

Valve broad-elliptical, almost round, with broad rounded ends. Length, 0.012 mm; breadth, 0.01. Axial area very narrow, central area somewhat dilated. Median line straight. Striæ radiate, in the middle alternately longer and shorter. Common in northern Europe. Reported from Kizaki Lake.

NAVICULA CRYPTOCEPHALA Kütz.

Navicula cryptocephala Kütz., Fr. Hustedt, Bacillar. (1930) 295, fig. 496.

Valve lanceolate with attenuate ends. Length, 0.019 to 0.025 mm; breadth, 0.0042 to 0.005. Axial area narrow, widened in the middle part. Striæ radiate, 15 to 18 in 0.01 mm. Not common. Reported from Kizaki Lake.

NAVICULA RHYNCHOCEPHALA Kütz.

Navicula rhynchocephala Kütz., Fr. Hustedt, Bacillar. (1930) 296, fig. 501.

Valve lanceolate with long ends. Length, 0.039 mm; breadth, 0.01. Central area broad. Striæ radiate, 13 to 14 in 0.01 mm. Not common. Reported from Aokiko and Kizaki Lakes.

NAVICULA ROSTELLATA Kütz. var. BIWENSIS var. nov. Plate 3, fig. 14.

Valve lanceolate with gradually attenuate ends. Length, 0.025 to 0.027 mm; breadth, 0.005. Axial area narrow. Central area dilated. Striæ 11 to 15 in 0.01 mm. Differs from the type in its regular lanceolate valves and coarser striæ. Uncommon.

NAVICULA COSTULATA Grun. fo. CURTA fo. nov. Plate 5, fig. 13.

Valve broad, rhomboid-lanceolate. Length, 0.009 mm; breadth, 0.0042. Striæ robust, radiate, 10 in 0.01 mm. Central area a broad rectangular stauros. Our specimens are shorter than the type. *Navicula costulata* is known from the bottoms of European lakes.

NAVICULA COSTULATA Grun. var. NIPPONICA var. nov. Plate 5, fig. 12.

Valves rhomboid-lanceolate with subrostrate ends. Length, 0.012 mm; breadth, 0.0042. Striæ robust, almost parallel, 9 in

0.01 mm. Differs from the type in its subrostrate ends. Common.

NAVICULA COSTULATA Grun. var. TENUIROSTRIS var. nov. Plate 5, fig. 16.

Valve lanceolate, undulate at the middle, long-attenuate at the ends. Length, 0.027 mm; breadth, 0.007. Costæ radiate, 6 in 0.01 mm. Central area a wide stauros. Differs from the type in its elongate ends. Uncommon.

NAVICULA RADIOSA Kütz. fo. NIPPONICA fo. nov. Plate 2, fig. 2; Plate 3, fig. 20.

Valve narrow-lanceolate, gradually attenuate, acuminate. Length, 0.04 to 0.042 mm; breadth, 0.0068 to 0.0085. Axial area narrow, linear, dilated in the middle. Striæ radiate, not lineolate, 8 to 11 in 0.01 mm. Differs from the type in its narrower valves. The type is known from Aokiko Lake.

NAVICULA PEREGRINA (Ehr.) Kütz. var. NIPPONICA var. nov. Plate 4, fig. 8.

Valve lanceolate, parallel in the middle part with abruptly attenuate ends. Length, 0.066 mm; breadth, 0.012. Striæ radiate, lineolate, 6 to 8 in 0.01 mm. Central area broad. Differs from the type in its parallel margins and abruptly attenuate ends. Not common.

NAVICULA MENISCULUS Schum. Plate 4, fig. 7; Plate 6, fig. 13.

Valve elliptical-lanceolate, broad in the middle and gradually attenuate towards the ends. Length, 0.027 to 0.042 mm; breadth, 0.01 to 0.012. Striæ radiate, lineolate, in the middle alternately longer and shorter, 8 to 11 in 0.01 mm. Common. Reported from Kizaki Lake.

NAVICULA REINHARDTII Grun.

Navicula Reinhardtii Grun., Fr. Hustedt, Bacillar. (1930) 301, fig. 519.

Valve elliptical with broad, obtuse ends. Length, 0.051 mm; breadth, 0.015. Striæ radiate, lineolate, 7 to 8 in 0.01 mm. Not common. A fresh-water species.

NAVICULA FALAISIENSIS Grun. var. NIPPONICA Skvortzow. Plate 3, fig. 3.

Navicula falaisiensis Grun. var. *nipponica* Skvortzow, Diatoms Kizaki Lake (1936) pl. 6, fig. 15.

Valve linear-lanceolate with parallel margins and subrostrate ends. Length, 0.015 mm; breadth, 0.005. Axial area almost round. Striæ slightly radiate, 18 in 0.01 mm. Differs from the type in its short valves. Reported from Kizaki Lake.

NAVICULA DICEPHALA (Ehr.) W. Smith var. NEGLECTA (Krasske) Hust. Plate 2, fig. 22.

Navicula dicephala (Ehr.) W. Smith var. *neglecta* (Krasske) HUSTEDT, Bacillar. (1930) 303, fig. 527.

Valve broad-linear, or linear-lanceolate, triundulate with rostrate ends. Length, 0.018 mm; breadth, 0.0068. Striæ radiate, 15 in 0.01 mm. Central area rectangular. The type was reported from Aokiko Lake. Uncommon.

NAVICULA PLACENTULA (Ehr.) Grun. Plate 7, fig. 7.

Navicula placentula (Ehr.) Grun., FR. HUSTEDT, Bacillar. (1930) 303, fig. 532.

Valve elliptical-lanceolate with rostrate ends. Length, 0.027 mm; breadth, 0.0085. Striæ radiate, not punctulate, 9 to 10 in 0.01 mm. Rare.

NAVICULA PLACENTULA (Ehr.) Grun. fo. ROSTRATA A. Mayer.

Navicula placentula (Ehr.) Grun. fo. *rostrata* A. Mayer, FR. HUSTEDT, Bacillar. (1930) 303–304, fig. 533.

Valve elliptical-lanceolate with rostrate ends. Length, 0.04 mm; breadth, 0.017. Striæ 10 in 0.01 mm. Reported from Kizaki Lake.

NAVICULA GASTRUM Ehr. fo. NIPPONICA fo. nov. Plate 8, fig. 8.

Valve broad elliptical-lanceolate with rostrate ends. Length, 0.29 mm; breadth, 0.01. Striæ radiate, 10 to 11 in 0.01 mm, in the middle alternately longer and shorter. Differs from the type in its rostrate ends. Not common.

NAVICULA EXIGUA (Greg.) O. Müll.

Navicula exigua (Greg.) O. Müll., FR. HUSTEDT, Bacillar. (1930) 305, fig. 538.

Valve elliptical-lanceolate with abruptly attenuate and capitate ends. Length, 0.02 mm; breadth, 0.006. Striæ radiate, in the middle alternately longer and shorter, 15 in 0.01 mm. Reported from Aokiko and Kizaki Lakes.

NAVICULA LANCEOLATA (Agardh) Kütz. var. NIPPONICA var. nov. Plate 2, fig. 18; Plate 7, fig. 5.

Valve narrow, lanceolate, gradually attenuate. Length, 0.056 to 0.091 mm; breadth, 0.0068 to 0.01. Striæ 10 to 11 in 0.01 mm. Differs from the type in its narrow valves. *Navicula lanceolata* is known from Aokiko Lake.

NAVICULA LANCEOLATA (Agardh) Kütz. var. CYMBULA (Donk.) Cleve.

Navicula lanceolata (Agardh) Kütz. var. *cymbula* (Donk.) Cleve, VAN HEURCK, Synopsis (1880–1881) pl. 7, fig. 32.

Valve lanceolate with long-acuminate ends. Length, 0.051 mm; breadth, 0.01. Striæ in the middle 8, at the ends 10, in 0.01 mm. Known from Kizaki Lake. Common in Biwa Lake.

NAVICULA HASTA Pant.

Navicula hasta Pant., FR. HUSTEDT, Bacillar. (1930) 306, fig. 541; SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 5, fig. 1.

Valve lanceolate with attenuate and slightly enlarged ends. Length, 0.127 mm; breadth, 0.018. Striæ 6 in 0.01 mm. Very common in Biwa Lake. Known from Europe, as a fossil in Hungary, and from Aokiko and Kizaki Lakes, Nippon.

NAVICULA HASTA Pant. var. GRACILIS var. nov. Plate 7, fig. 9.

Valve with long-attenuate ends. Length, 0.051 mm; breadth, 0.01. Striæ radiate, lineolate, 9 in 0.01 mm. Differs from the type in its gradually attenuate ends and smaller size. A form related to *Navicula lanceolata* var. *cymbula*. Not common.

NAVICULA UNDULATA sp. nov. Plate 4, fig. 2; Plate 7, fig. 6.

Valve elliptical-lanceolate, triundulate with attenuate ends. Length, 0.054 to 0.064 mm; breadth, 0.013 to 0.015. Striæ radiate, lineolate, 7 to 8 in 0.01 mm. Axial area narrow, central area rounded. A species related to *Navicula hasta* Pant.

NAVICULA TUSCULA (Ehr.) Grun. var. DENSISTRIATA var. nov. Plate 4, fig. 9.

Valve elliptical, attenuate and capitate. Length, 0.024 to 0.025 mm; breadth, 0.007 to 0.01. Striæ crossed by four, broad, longitudinal, undulate bands, 20 to 24 in 0.01 mm. Differs from the type in its coarser striæ. Uncommon.

NAVICULA PUSIO Cleve.

Navicula Pusio CLEVE, Synopsis Navicul. Diatom. (1885) 9, pl. 2, fig. 3.

Valve elliptical with broad rostrate ends. Length, 0.017 mm; breadth, 0.0076. Striæ fine, about 24 to 28 in 0.01 mm. Common. Known from Rotorua Lake, New Zealand, and Aokiko and Kizaki Lakes, Nippon.

NAVICULA PUSIO Cleve fo. MINUTA fo. nov.

Differs from the type in its smaller size. Length, 0.01 mm; breadth, 0.0034. Rare.

NAVICULA SIMILIS Krasske var. NIPPONICA var. nov. Plate 3, fig. 2.

Valve broad-elliptical with broad rostrate ends. Length, 0.018 mm; breadth, 0.0068. Striæ radiate, in the middle of unequal length, 17 to 18 in 0.01 mm. Central area almost rectangular. Differs from the type in its striæ of unequal length in the middle part of the valve. Rare.

NAVICULA PALEA Skvortzow.

Navicula palea SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 8, fig. 4.

Valve linear, lanceolate, narrow, attenuate with slightly capitate ends. Length, 0.025 mm; breadth, 0.0045. Striæ radiate, 15 in 0.01 mm. Known from Kizaki Lake.

NAVICULA SCUTELLOIDES W. Sm. Plate 2, fig. 1.

Navicula scutelloides W. Sm., A. SCHMIDT, Atlas Diatom. (1875) pl. 6, fig. 34.

Valve broad-elliptical with broad rounded ends. Length, 0.015 to 0.02 mm; breadth, 0.011 to 0.014. Median line straight. Axial area somewhat dilated in the middle. Striæ radiate in the border, of unequal length, 10 to 15 in 0.01 mm; puncta distinct, 18 in 0.01 mm. Rare. A distinct species by the structure of the valve, related to *Cocconeis pliocaenica* Krasske, known from the Upper Pliocene of Germany.

NAVICULA SOODENSIS Krasske. Plate 5, fig. 8.

Navicula soodensis Krasske, FR. HUSTEDT, Bacillar. (1930) 276, fig. 457.

Valve linear-elliptical with almost parallel margins and obtuse ends. Length, 0.023 mm; breadth, 0.005. Striæ slightly radiate, 18 in 0.01 mm. Median line filiform, straight. Axial area very narrow. Central area a broad rectangular stauros. The type is known from brackish water in Europe.

NAVICULA KAWAMURÆ sp. nov. Plate 5, fig. 10.

Valve lanceolate, undulate at the middle, abruptly attenuate at the ends. Length, 0.027 mm; breadth, 0.0045. Striæ parallel, 18 to 20 in 0.01 mm. Axial area a broad fascia, reaching one-third of the valve length. Not common. Named in honor of Prof. Dr. T. Kawamura, of Kyoto.

NAVICULA MINUTA sp. nov. Plate 3, fig. 17.

Valve rhombic-elliptic, broad and acute. Length, 0.015 mm; breadth, 0.005. Striæ parallel, 24 in 0.01 mm. Median line straight. Axial area linear, slightly enlarged. Central area a broad fascia, reaching about one-third of the valve length. Belongs to Naviculæ lineolatæ Cleve. Not common.

NAVICULA ACHNANTHOIDES sp. nov. Plate 7, fig. 8.

Valve lanceolate-elliptical, with parallel margins, and gradually attenuate towards the ends. Length, 0.049 mm; breadth, 0.01. Median line straight, not reaching the ends. Axial area linear, central area broad and orbicular. Striæ 11 to 12 in the middle, 16 to 17 at the ends, in 0.01 mm. Both ends with transverse, rounded, siliceous ribs. Uncommon.

NAVICULA NIPPON sp. nov. Plate 5, fig. 17.

Valve elliptical or rhomboidal with parallel margins and broad rostrate ends. Length, 0.024 mm; breadth, 0.0068. Median line straight, central pores curved in the same direction. Axial area narrow, central area a broad, widened, rectangular stauros. Striæ slightly radiate, divergent in the middle, convergent at the ends. Common.

PINNULARIA UNDULATA Greg. var. NIPPONICA var. nov. Plate 4, fig. 12; Plate 8, fig. 2.

Valve lanceolate-elliptical with triundulate, attenuate, and rounded ends. Length, 0.04 to 0.068 mm; breadth, 0.0068 to 0.01. Striæ 18 in 0.01 mm. Axial area narrow, central area a broad stauros. Differs from variety *subundulata* Grun. in its broad stauros.

PINNULARIA MOLARIS Grun.

Pinnularia molaris Grun., Fr. Hustedt, Bacillar. (1930) 316, fig. 568.

Valve linear or linear-lanceolate with slightly attenuate and rounded ends. Length, 0.02 mm; breadth, 0.005. Striæ 18 in 0.01 mm. Central area a broad stauros. Common. Reported from Kizaki Lake.

PINNULARIA INTERRUPTA W. Smith.

Pinnularia interrupta W. Smith, Fr. Hustedt, Bacillar. (1930) 317, fig. 573.

Valve linear with parallel margins and capitate ends. Length, 0.04 mm; breadth, 0.0068. Striæ divergent in the middle and convergent at the ends, 10 to 11 in 0.01 mm. Common. Known from fresh water.

PINNULARIA BRAUNII (Grun.) Cleve var. AMPHICEPHALA (A. Mayer) Hust. fo. NIPPONICA fo. nov. Plate 2, fig. 20.

Valve elliptical-lanceolate with capitate ends. Length, 0.034 mm; breadth, 0.0068. Striæ 15 in 0.01 mm. Differs from the type in its slightly constricted margins. Uncommon.

PINNULARIA BRAUNII (Grun.) Cleve var. NIPPONICA var. nov. Plate 5, fig. 3.

Valve elliptical-lanceolate with parallel margins and rostrate obtuse ends. Length, 0.032 mm; breadth, 0.006. Striæ 15 in

0.01 mm. Differs from variety *amphicephala* in its rostrate and capitate ends. Uncommon.

PINNULARIA POLYONCA (Breb.) O. Müll. var. NIPPONICA var. nov. Plate 6, fig. 3.

Valve lanceolate with triundulate margins. Ends subtruncate. Length, 0.047 mm; breadth, 0.0075. Striæ radiate, 11 to 12 in 0.01 mm. Differs from the type in having narrow, not capitate, ends and a broad middle part. Uncommon.

PINNULARIA KARELICA Cleve var. JAPONICA Hust.

Pinnularia karelica Cleve var. *japonica* HUSTEDT, Bacillar. aus dem Aokikosee in Japan 165, pl. 5, fig. 3.

Valve linear, slightly enlarged in the middle part, rounded and capitate at the ends. Length, 0.051 mm; breadth, 0.012. Reported from Aokiko and Kizaki Lakes.

PINNULARIA PLATYCEPHALA (Ehr.) Cleve var. HATTORIANA Meister.

Pinnularia platycephala (Ehr.) Cleve var. *Hattoriana* MEISTER, Beiträge zur Bacillar. Japans. (1914) 2, 228–229, pl. 8, figs. 6, 7.

Valve linear, triundulate with capitate ends. Length, 0.074 mm; breadth, 0.009. Striæ radiate, interrupted in the middle part, 9 in 0.01 mm. Reported from Tokyo, Kizaki Lake, in Nippon; from Poyang Lake, Hunan, China; and from Battater, Scotland.

PINNULARARIA PLATYCEPHALA (Ehr.) Cleve var. HATTORIANA Meister fo. ANGUSTIOR fo. nov. Plate 7, fig. 3.

Valve linear, 5-undulate with subtruncate ends. Length, 0.081 mm; breadth, 0.01. Striæ radiate, 8 in 0.01 mm. Differs from variety *Hattoriana* in its narrower valves. Uncommon.

PINNULARIA BOREALIS Ehr.

Pinnularia borealis Ehr., FR. HUSTEDT, Bacillar. (1930) 326, fig. 597.

Valve linear or linear-elliptical with broad rounded ends. Length, 0.034 mm; breadth, 0.008. Common. Reported from Kizaki Lake.

PINNULARIA GIBBA Ehr. Plate 5, fig. 2.

Pinnularia gibba Ehr., FR. HUSTEDT, Bacillar. (1930) 327, fig. 600.

Valve linear-lanceolate with slightly apiculate apex. Length, 0.056 to 0.058 mm; breadth, 0.0076 to 0.0085. Striæ radiate, 9 in 0.01 mm. Common. Reported from Kizaki Lake.

PINNULARIA GIBBA Ehr. var. BIWENSIS var. nov. Plate 2, fig. 6.

Valve broad with slightly capitate and attenuate apex. Length, 0.066 mm; breadth, 0.009. Striæ divergent in the middle, convergent at the ends, 11 to 12 in 0.01 mm. Median line

with long, terminal, reflexed fissures. Differs from variety *nipponica* Skv. by its capitate ends.

PINNULARIA ACROSPHÆRIA Breb. var. LÆVIS Cleve.

Pinnularia acrosphæria A. SCHMIDT, Atlas Diatom. (1876) pl. 43, fig. 18.

Valve linear, more or less gibbous in the middle and at the ends. Length, 0.061 mm; breadth, 0.01. Axial area broad, hyaline. Striæ 9 to 10 in 0.01 mm. Known from New Zealand and from the Blue Mountains, Australia.

PINNULARIA MACILENTA Ehr. Cleve.

Pinnularia macilenta Ehr. Cleve, FR. HUSTEDT, Bacillar. (1930) 331, fig. 613.

Valve linear with parallel margins and broad rounded ends. Length, 0.183 mm; breadth, 0.025. Costæ almost parallel, 5 in 0.01 mm. Known from Europe.

PINNULARIA MAJOR (Kütz.) Cleve var. LINEARIS Cleve.

Pinnularia major (Kütz.) Cleve var. *linearis* Cleve, FR. HUSTEDT, Bacillar. (1930) 331; PANTOCSEK, Fossile Bacillar. Ungarns (1903) 3, pl. 7, fig. 113.

Valve linear with broad rounded ends. Length, 0.161 mm; breadth, 0.022. Striæ 6 in 0.01 mm. Axial area enlarged. Central area outwardly dilated. Common. Reported from Kizaki Lake.

PINNULARIA MAJOR (Kütz.) Cleve var. NIPPONICA var. nov. Plate 8, fig. 6.

Valve linear with parallel margins and abruptly attenuate and subrostrate ends. Length, 0.153 mm; breadth, 0.017. Striæ radiate, divergent in the middle, convergent at the ends, 6 in 0.01 mm. Differs from the type in its subrostrate and narrower valves. Uncommon.

PINNULARIA VIRIDIS (Nitzsch) Ehr. var. FALLAX Cleve. Plate 8, fig. 11.

Pinnularia viridis (Nitzsch) Ehr. var. *fallax* Cleve, FR. HUSTEDT, Bacillar. (1930) 335.

Valve linear, obtuse at the ends. Length, 0.042 to 0.052 mm; breadth, 0.01 to 0.013. Striæ 8 to 9 in 0.01 mm. Striæ from one side of the valve abrupt. Reported from Kizaki Lake.

PINNULARIA VIRIDIS (Nitzsch) Ehr. var. LEPTOGONGYLA (Ehr. Grun.) Cleve. Plate 6, fig. 10.

Pinnularia viridis (Nitzsch) Ehr. var. *leptogongyla* (Ehr. Grun.) Cleve, FR. HUSTEDT, Bacillar. (1930) 335.

Valve linear with broad rounded ends. Length, 0.051 mm; breadth, 0.012. Striæ 9 to 10 in 0.01 mm. Central area broadly rounded. Not common. Reported from Kizaki Lake.

PINNULARIA NAKAII sp. nov. Plate 8, fig. 4.

Valve lanceolate-linear, in the middle slightly undulate, gradually attenuate towards the ends. Ends slightly capitate, acuminate. Length, 0.99 mm; breadth, 0.012. Median line straight with large, comma-shaped, terminal fissures. Axial area narrow-linear, broadened towards the central area. Central area a broad stauros, truncate outwards. Costæ radiate, divergent in the middle, convergent at the ends, without a longitudinal band. Not common. Named in honor of Prof. Dr. T. Nakai, of Tokyo.

PINNULARIA CUCUMIS sp. nov. Plate 8, fig. 3.

Valve broad-linear, almost rectangular, with broad rounded ends. Length, 0.105 mm; breadth, 0.02. Median line filiform, with strong, curved, terminal fissures. Axial area linear, dilated from both sides. Central area round. Striæ curved, divergent in the middle, convergent at the ends, 7 to 9 in 0.01 mm, with two longitudinal lines. Common.

PINNULARIA STRIATULA sp. nov. Plate 5, fig. 6.

Valve linear-lanceolate with parallel margins, slightly attenuate, and with broad rounded ends. Length, 0.054 mm; breadth, 0.0068. Median line linear, terminal fissures comma-shaped. Axial area very narrow, central areas slightly dilated. Striæ parallel, striolate, 11 to 12 in 0.01 mm. Uncommon.

PINNULARIA LACUS BIWA sp. nov. Plate 6, fig. 8.

Valve elliptical-lanceolate with capitate ends. Length, 0.085 mm; breadth, 0.018. Median line straight, with large comma-shaped terminal fissures. Axial area broad, passing into a broad central area, forming a stauros, truncate outwards. Striæ divergent in the middle, convergent at the ends, 9 in 0.01 mm. Longitudinal lines absent. Common.

PINNULARIA KAWAMURÆ sp. nov. Plate 7, fig. 12.

Valve elliptical-lanceolate, middle part undulate, gradually attenuate towards the ends. Length, 0.088 mm; breadth, 0.018. Median line filiform, enlarged in the middle part. Axial areas broad, passing into a broad central area, forming a broad truncate stauros. Striæ radiate, 8 to 9 in 0.01 mm, with two longitudinal bands. Named in honor of Prof. Dr. T. Kawamura, of Kyoto.

PINNULARIA NIPPONICA Skvortzow. Plate 3, fig. 8; Plate 8, fig. 5.

Pinnularia nipponica SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 7, fig. 12.

Valve linear-lanceolate, constricted in the middle, attenuate and subrostrate at the ends. Length, 0.068 to 0.076 mm; breadth, 0.012 to 0.013. Costæ divergent in the middle and convergent at the ends, forming a stauros in the middle part. Median line filiform, with comma-shaped terminal fissures. Longitudinal bands distinct. Common. A species related to *Pinnularia esox* Ehr. Reported from Kizaki Lake.

AMPHORA OVALIS Kütz.

Amphora ovalis Kütz., FR. HUSTEDT, Bacillar. (1930) 342, fig. 628.

Valve broad-elliptical with curved axial area. Length, 0.051 mm; breadth, 0.018. Not common. Reported from Aokiko Lake.

AMPHORA OVALIS Kütz. var. LIBYCA (Ehr.) Cleve. Plate 6, fig. 7.

Amphora ovalis Kütz. var. *libyca* (Ehr.) Cleve, A. SCHMIDT, Atlas Diatom. (1875) pl. 26, fig. 105.

Differs from the type in its narrow valves. Length, 0.032 to 0.064 mm; breadth, 0.007 to 0.025. Striæ 10 to 12 in 0.01 mm. Reported from Kizaki Lake.

AMPHORA OVALIS Kütz. var. PEDICULUS Kütz.

Amphora ovalis Kütz. var. *pediculus* Kütz., FR. HUSTEDT, Bacillar. (1930) 343, fig. 629.

Valve very small. Length, 0.013 mm; breadth, 0.004. Striæ 15 in 0.01 mm. Known from Aokiko and Kizaki Lakes.

AMPHORA PERPUSILLA Grun.

Amphora perpusilla Grun., FR. HUSTEDT, Bacillar. (1930) 343, fig. 627.

Valve elliptical, slightly siliceous. Length, 0.0085 mm; breadth, 0.002. Striæ 22 in 0.01 mm. Reported from Kizaki Lake.

AMPHORA DELPHINEA (Bailey) A. S. var. MINOR Cleve.

Amphora delphinea (Bailey) A. S. var. *minor* CLEVE, Synopsis Navicul. Diatom. (1895) 2, 134; A. SCHMIDT, Atlas Diatom. (1876) pl. 40, fig. 25; SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 3, fig. 12.

Frustule elliptical-rectangular. Length, 0.057 mm; breadth, 0.017. This American species is not common in Biwa Lake. Found also in Kizaki Lake.

CYMBELLA CUSPIDATA Kütz.

Cymbella cuspidata Kütz., A. SCHMIDT, Atlas Diatom. (1875) pl. 9, figs. 50, 53–55.

Valve broad, linear-lanceolate with abruptly attenuate ends. Length, 0.049 to 0.054 mm; breadth, 0.012 to 0.02. Striæ 9 to 11 in 0.01 mm. Common. Reported from Kizaki Lake.

CYMBELLA PROSTATA (Berkeley) Cleve.

Cymbella prostata (Berkeley) Cleve, VAN HEURCK, Synopsis (1880–1881) 65, pl. 3, figs. 9–11.

Valve boat-shaped with gibbous dorsal and slightly concave ventral margins. Length, 0.051 mm; breadth, 0.015. Striæ, dorsal 7, ventral 8, in 0.01 mm. A species typical of Arctic and alpine regions. Reported from Aokiko and Kizaki Lakes.

CYMBELLA HETEROPLEURA Ehr. var. MINOR Cleve.

Cymbella sp., A. SCHMIDT, Atlas Diatom. (1875) pl. 9, figs. 51, 52.

Valve with rostrate and truncate ends. Length, 0.062 mm; breadth, 0.018. Striæ 8 in 0.01 mm. An Arctic diatom known from Spitsbergen, Beeren Island, Norway, Scotland, Siberia, and Aokiko Lake.

CYMBELLA HYBRIDA Grun.

Cymbella hybrida Grunow, SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 5, fig. 23.

Valve naviculiform with truncate ends. Length, 0.06 to 0.074 mm; breadth, 0.0085 to 0.01. Striæ lineolate, 8 in 0.01 mm. Reported from Kizaki Lake. Common in Biwa Lake.

CYMBELLA TUMIDA (Breb.) Van Heurck.

Cymbella tumida (Breb.) Van Heurck, FR. HUSTEDT, Bacillar. (1930) 366, fig. 677.

Valve cymbiform with rostrate ends. Striæ divergent in the middle, convergent at the ends. Length, 0.045 mm; breadth. 0.015. Not common. Reported from Aokiko and Kizaki Lakes.

CYMBELLA TUMIDA (Breb.) Van Heurck var. BOREALIS Grun.

Cymbella tumida (Breb.) van Heurck var. *borealis* Grun., SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 11, fig. 16.

Differs from the type in the valve being not attenuate at the ends. Length, 0.072 mm; breadth, 0.019. Reported from Aokiko and Kizaki Lakes.

CYMBELLA CISTULA (Hemprich) Grun.

Cymbella cistula (Hemprich) Grun., Fr. Hustedt, Bacillar. (1930) 363, fig. 676*a*.

Valve lunate, undulate. Length, 0.062 to 0.068 mm; breadth, 0.012 to 0.013. Striæ 8 to 10 in 0.01 mm. Near the central nodule the striæ are interrupted by two puncta. Known from Aokiko and Kizaki Lakes.

CYMBELLA SINUATA Greg.

Cymbella sinuata Greg., Fr. Hustedt, Bacillar. (1930) 361, fig. 668*a*, *b*.

Valve asymmetrical, lanceolate, obtuse. Length, 0.012 mm; breadth, 0.034. Striæ 15 in 0.01 mm. Reported from Aokiko and Kizaki Lakes.

CYMBELLA VENTRICOSA Kütz.

Cymbella ventricosa Kütz., Fr. Hustedt, Bacillar. (1930) 359, fig. 661.

Valve asymmetrical with acute ends. Length, 0.028 mm; breadth, 0.007. Striæ 9 in 0.01 mm. Also reported from Aokiko and Kizaki Lakes.

CYMBELLA TUMIDULA Grun.

Cymbella tumidula Grun., A. Schmidt, Atlas Diatom. (1931) pl. 376, figs. 14–16.

Valve broad-elliptical with rostrate, slightly acuminate ends. Length, 0.034 mm; breadth, 0.01. Striæ 10 to 11 in 0.01 mm. Near the central nodule two isolated puncta. Common in Biwa Lake. Known from tropical districts.

CYMBELLA TURGIDULA Grun. var. NIPPONICA var. nov. Plate 2, fig. 8; Plate 4, fig. 4.

Valve boat-shaped with rostrate ends. Median line arcuate. Length, 0.037 mm; breadth, 0.01. Striæ 10 in 0.01 mm. Near the central area two isolated puncta. Differs from the type in its elongate valve, slightly undulate ventral margin, and broad rostrate ends. Common.

CYMBELLA LATA Grun. var. NIPPONICA var. nov. Plate 3, fig. 6.

Valve asymmetrical with subrostrate ends. Length, 0.039 mm; breadth, 0.012. Striæ robust, 10 in 0.01 mm. Differs from the type in its asymmetrical valve and undulate dorsal margin. Not common.

CYMBELLA NIPPONICA sp. nov. Plate 5, figs. 20 and 23.

Valve broad-elliptical with undulate margin and rostrate or subrostrate ends. Length, 0.029 mm; breadth, 0.013 to 0.015.

Striæ robust, radiate, striolate, in the middle alternately longer and shorter with one isolated punctum, 8 to 12 in 0.01 mm. Uncommon.

DIDYMOSPHENIA GEMINATA (Lyngb.) M. Schmidt. Plate 8, fig. 10.

Didymosphenia geminata (Lyngb.) M. Schmidt, Fr. Hustedt, Bacillar. (1930) 367, fig. 682.

Valve clavate, robust. Length, 0.132 mm; breadth, 0.04. Rare. Common in alpine regions.

GOMPHONEMA PARVULUM (Kütz.) Grun.

Gomphonema parvulum (Kütz.) Grun., Fr. Hustedt, Bacillar. (1930) 372, fig. 713*a*.

Valve lanceolate-attenuate towards the ends. Length, 0.02 mm; breadth, 0.005. Striæ 12 in 0.01 mm. Known from Kizaki Lake.

GOMPHONEMA PARVULUM (Kütz.) Grun. var. EXILISSIMA Grun. Plate 2, fig. 13.

Gomphonema parvulum (Kütz.) Grun. var. *exilissima* Grun., Van Heurck, Synopsis (1880–1881) pl. 25, fig. 12.

Valve narrower than that of the type. Length, 0.015 to 0.018 mm; breadth, 0.005 to 0.006. Striæ 15 in 0.01 mm. Isolated puncta indistinct. Reported from Kizaki Lake.

GOMPHONEMA BERGGRENII Cleve. Plate 5, fig. 22.

Gomphonema Berggrenii Cleve, A. Schmidt, Atlas Diatom. (1902) pl. 240, fig. 28.

Valve elliptical, clavate, with capitate apex, broad middle part, attenuate towards the end. Length, 0.035 mm; breadth, 0.008. Striæ 8 in 0.01 mm. Reported from New Zealand and Kizaki Lake.

GOMPHONEMA ACUMINATUM Ehr. var. CORONATA (Ehr.) W. Smith.

Gomphonema acuminatum Ehr. var. *coronata* (Ehr.) W. Smith., Fr. Hustedt, Bacillar. (1930) 370, fig. 684.

Valve clavate, biconstricted with apiculate apex. Length, 0.072 mm; breadth, 0.011. Not common. Known from Kizaki Lake.

GOMPHONEMA CONSTRICTUM Ehr. var. CAPITATA (Ehr.) Cleve.

Gomphonema constrictum Ehr. var. *capitatum* (Ehr.) Cleve, Fr. Hustedt, Bacillar. (1930) 377, fig. 715.

Valve clavate with broad apex. Length, 0.03 to 0.042 mm; breadth, 0.0085. Striæ 12 to 14 in 0.01 mm. Reported from Aokiko and Kizaki Lakes.

GOMPHONEMA INTRICATUM Kütz.

Gomphonema intricatum Kütz., Fr. Hustedt, Bacillar. (1930) 375, fig. 697.

Valve clavate, elongate, apex slightly capitate, middle little undulate. Length, 0.028 mm; breadth, 0.004. Reported from Kizaki Lake.

GOMPHONEMA INTRICATUM Kütz. var. PUMILA Grun. Plate 3, fig. 12.

Gomphonema intricatum Kütz. var. *pumila* Grun., Fr. Hustedt, Bacillar. (1930) 375, fig. 699.

Valve minute, lanceolate with attenuate and rounded ends. Length, 0.015 mm; breadth, 0.0028. Striæ 15 in 0.01 mm. Common. With the type.

GOMPHONEMA AUGUR Ehr. var. GAUTIERI Van Heurck.

Gomphonema augur Ehr. var. *Gautieri* Van Heurck, Fr. Hustedt, Bacillar. (1930) 372, fig. 689.

Valve clavate with broad upper part and apiculate apex. End narrow. Length, 0.054 mm; breadth, 0.013. Reported from Kizaki Lake.

GOMPHONEMA LANCEOLATUM Ehr. var. INSIGNIS (Gregory) Cleve. Plate 4, fig. 6.

Gomphonema lanceolatum Ehr. var. *insignis* (Gregory) Cleve, Fr. Hustedt, Bacillar. (1930) 376, fig. 701.

Valve lanceolate with attenuate ends. Length, 0.042 to 0.047 mm; breadth, 0.007 to 0.009. Striæ 10 in 0.01 mm. Isolated puncta distinct. Reported from Kizaki Lake. Common in Biwa Lake.

GOMPHONEMA VASTUM Hust. var. ELONGATA Skvortzow. Plate 2, fig. 17.

Gomphonema vastum Hust. var. *elongata* Skvortzow, Diatoms Kizaki Lake (1936) pl. 13, figs. 33, 40.

Valve elongate-lanceolate-linear with obtuse ends. Length, 0.042 mm; breadth, 0.005 to 0.006. Striæ marginal, 8 to 9 in 0.01 mm. Isolated puncta distinct. Differs from the type in its elongate valve. Not common. Known from Kizaki Lake.

GOMPHONEMA VASTUM Hust. var. MAXIMA var. nov. Plate 8, fig. 7.

Larger than the type. Length, 0.062 mm; breadth, 0.008. Striæ marginal, 15 in 0.01. Uncommon.

GOMPHONEMA LINGULATUM Hust. Plate 3, fig. 13; Plate 6, fig. 16.

Gomphonema lingulatum Hustedt, Bacillar. aus dem Aokikosee in Japan 166, pl. 5, fig. 5.

Valve clavate. The upper part broadly rounded and abruptly apiculate. Lower part attenuate and obtuse. Length, 0.018

mm; breadth, 0.008. Striæ marginal, 15 in 0.01 mm. Isolated puncta absent. Not common. Known from Aokiko and Kizaki Lakes.

GOMPHONEMA LINGULATUM Hust. var. ELONGATUM var. nov. Plate 3, fig. 11.

Valve elongate, slightly biconstricted, enlarged in the upper part, with apiculate apex. Length, 0.049 mm; breadth, 0.01. Striæ marginal, 13 to 14 in 0.01 mm. No isolated puncta. Not common.

GOMPHONEMA LINGULATUM Hust. var. PUMILA var. nov. Plate 2, fig. 19.

Valve minute, rounded at apex, attenuate at the end. Length, 0.01 mm; breadth, 0.005. Striæ marginal, 15 in 0.01 mm. No isolated puncta. Differs from the type in its rounded apex and small size. Not common.

EPITHEMIA ZEBRA (Ehr.) Kütz. var. PORCELLUS (Kütz.) Grun.

Epithemia zebra (Ehr.) Kütz. var. *porcellus* (Kütz.) Grun., Fr. Hustedt, Bacillar. (1930) 385, fig. 731.

Valve slightly curved, on the ventral side almost straight, on the dorsal side undulate with rostrate-truncate ends. Length, 0.051 mm; breadth, 0.008. The type is known from Aokiko Lake.

EPITHEMIA ZEBRA (Ehr.) Kütz. var. SAXONICA (Kütz.) Grun.

Epithemia zebra (Ehr.) Kütz. var. *saxonica* (Kütz.) Grun., Fr. Hustedt, Bacillar. (1930) 385, fig. 730.

Valve genuflexed with attenuate, subrostrate ends. Length, 0.025 to 0.037 mm; breadth, 0.0065 to 0.007. Costæ 3 to 4, striæ 13 to 14, in 0.01 mm. Common. Known from Kizaki Lake.

EPITHEMIA TURGIDA (Ehr.) Kütz. Plate 3, fig. 10.

Epithemia turgida (Ehr.) Kütz., A. Schmidt, Atlas Diatom. (1904) pl. 250, figs. 5, 6.

Valve robust, broad, with short rounded ends. Length, 0.056 to 0.093 mm; breadth, 0.014 to 0.017. Costæ 4 in 0.01 mm. Common. Known from fresh water.

EPITHEMIA SOREX Kütz.

Epithemia sorex Kütz., Fr. Hustedt, Bacillar. (1930) 388, fig. 736.

Valve genuflexed, attenuate towards the capitate ends. Length, 0.037 mm; breadth, 0.0085. Reported from Aokiko and Kizaki Lakes.

EPITHEMIA SOREX Kütz. var. GRACILIS Hust. Plate 2, fig. 11.

Epithemia sorex Kütz. var. *gracilis* HUSTEDT, Bacillar. (1930) 388, fig. 737.

Valve curved, gradually attenuate towards the rounded ends. Length, 0.034 mm; breadth, 0.0055. Costæ 4, striæ 15, in 0.01 mm. Not common.

EPITHEMIA HYNDMANII W. Smith.

Epithemia Hyndmanii W. Smith, FR. HUSTEDT, Bacillar. (1930) 387, fig. 735.

Valve robust, lunate with elongate and obtuse ends. Length, 0.195 mm; breadth, 0.023. Costæ 3 in 0.01 mm. Common. Known from fresh water.

RHOPALODIA PARALLELA (Grun.) O. Müll.

Rhopalodia parallela (Grun.) O. Müll., FR. HUSTEDT, Bacillar. (1930) 389, fig. 739.

Valve linear, slightly reflexed in the middle. Length, 0.08 mm; breadth, 0.02. Common. Known from Kizaki Lake and common in alpine lakes of Europe.

RHOPALODIA GIBBA (Ehr.) O. Müll.

Rhopalodia gibba (Ehr.) O. Müll., FR. HUSTEDT, Bacillar. (1930) 390, fig. 740.

Valve linear, undulate and reflexed in the middle part. Length, 0.017 mm; breadth, 0.01. Striæ 7 in 0.01 mm. Reported from Aokiko and Kizaki Lakes.

RHOPALODIA GIBBA (Ehr.) O. Müll. var. VENTRICOSA (Ehr.) Grun.

Rhopalodia gibba (Ehr.) O. Müll. var. *ventricosa* (Ehr.) Grun., FR. HUSTEDT, Bacillar. (1930) 391, fig. 741.

Valve broad and short. Length, 0.045 mm; breadth, 0.0068. Common.

HANTZSCHIA AMPHIOXUS (Ehr.) Grun.

Hantzschia amphioxus (Ehr.) Grun., FR. HUSTEDT, Bacillar. (1930) 394, fig. 747.

Valve linear or lanceolate with subrostrate ends. Margin constricted on one side, undulate on the other. Length, 0.032 mm; breadth, 0.006. Uncommon. Reported from Kizaki Lake.

NITZSCHIA TRYBLIONELLA Hantzsch var. DEBILIS (Arnott) A. Mayer. Plate 2, fig. 24.

Nitzschia tryblionella Hantzsch var. *debilis* (Arnott) A. Mayer., FR. HUSTEDT, Bacillar. (1930) 400, fig. 759.

Valve broad-elliptical with cuneate, rounded ends. Margins parallel. Length, 0.017 mm; breadth, 0.0085. Costæ fine, 11 to 12 in 0.01 mm. Not common. Known from fresh and brackish waters.

NITZSCHIA TRYBLIONELLA Hantzsch var. VICTORIÆ Grun. Plate 6, fig. 11.

Nitzschia tryblionella Hantzsch var. *victoriæ* Grun., FR. HUSTEDT, Bacillar. (1930) 399, fig. 758.

Valve elliptical, slightly constricted. Length, 0.047 mm; breadth, 0.015. Costæ robust, 5 in 0.01 mm. Common. A brackish-water diatom.

NITZSCHIA ACUTA Hantzsch. Plate 5, fig. 4.

Nitzschia acuta Hantzsch, FR. HUSTEDT, Bacillar. (1930) 412, fig. 790.

Valve long linear-lanceolate, gradually attenuate towards the ends. Length, 0.103 mm; breadth, 0.0042. Costæ 6 in 0.01 mm. Striæ very fine and indistinct. Not common. A fresh-water species.

NITZSCHIA LORENZIANA Grun. var. SUBTILIS Grun. Plate 5, fig. 9.

Nitzschia Lorenziana Grun. var. *subtilis* Grun., A. SCHMIDT, Atlas Diatom. (1921) pl. 335, figs. 6–8.

Valve sygmoid-linear, attenuate towards the ends. Length, 0.119 mm; breadth, 0.0051. Costæ 15 in 0.01 mm. Striæ indistinct. Not common. Known from brackish water.

NITZSCHIA PALEA (Küts.) W. Smith.

Nitzschia palea (Kütz.) W. Smith, FR. HUSTEDT, Bacillar. (1930) 416, fig. 801.

Valve linear-lanceolate with gradually attenuate and slightly capitate ends. Length, 0.0204 mm; breadth, 0.0034. Costæ 15 in 0.01 mm. Striæ very fine, indistinct. Not common. Known from Kizaki Lake.

NITZSCHIA CLAUSII Hantzsch. Plate 7, fig. 10.

Nitzschia Clausii Hantzsch, VAN HEURCK, Synopsis (1880–1881) pl. 66, fig. 10.

Valve sigmoid-linear with parallel margins and abruptly attenuate and curved ends. Length, 0.052 mm; breadth, 0.003. Costæ 10 in 0.01 mm. Striæ indistinct. Uncommon. Known from brackish water.

NITZSCHIA INTERRUPTA (Reich.) Hust.

Nitzschia interrupta (Reich.) HUSTEDT, Bacillar. aus dem Aokikosee in Japan 168.

Valve lanceolate with attenuate and capitate ends. Costæ robust, reaching about the middle part of the valve. Length, 0.029 to 0.003 mm; breadth, 0.007. Common. Known from Aokiko and Kizaki Lakes.

NITZSCHIA ACICULARIS W. Smith var. NIPPONICA Skvortzow.

Nitzschia acicularis W. Smith var. *nipponica* SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 13, fig. 7.

Valve hyaline, lanceolate with long beaks. Length, 0.01 mm; breadth, 0.0025. Common. Known from Kizaki Lake.

CYMATOPLEURA SOLEA (Breb.) W. Smith.

Cymatopleura solea (Breb.) W. Smith., Fr. HUSTEDT, Bacillar. (1930) 425, fig. 823*a*.

Valve broad-linear, constricted in the middle, enlarged and cuneate at the ends. Length, 0.085 mm; breadth, 0.015. Known from Aokiko Lake.

CYMATOPLEURA ELLIPTICA (Breb.) W. Smith var. CONSTRICTA Grun.

Cymatopleura elliptica (Breb.) W. Smith var. *constricta* Grun., FR. HUSTEDT, Bacillar. (1930) 428, fig. 826.

Valve broad-elliptical, slightly constricted in the middle part and broad-cuneate at the ends. Length, 0.161 mm; breadth, 0.059. Striæ 3 in 0.01 mm. Not common.

SURIRELLA BISERIATA Breb.

Surirella biseriata Breb., FR. HUSTEDT, Bacillar. (1930) 432, figs. 331–332.

Valve linear-elliptical or lanceolate-elliptical with parallel margins and gradually attenuate at the ends. Length, 0.111 mm; breadth, 0.02. Marginal keel forming wings. Costæ robust, short, 3 in 0.01 mm, not reaching the pseudoraphe. Common. Reported from Aokiko and Kizaki Lakes.

SURIRELLA ROBUSTA Ehr. var. SPLENDIDA (Ehr.) Van Heurck.

Surirella robusta Ehr. var. *splendida* (Ehr.) Van Heurck, FR. HUSTEDT, Bacillar. (1930) 437, figs. 851–852.

Valve elongate-ovate with robust costæ and alæ. Length, 0.091 to 0.096 mm; breadth, 0.03. Common. Reported from Aokiko and Kizaki Lakes.

SURIRELLA ROBUSTA Ehr. var. NIPPONICA var. nov. Plate 5, fig. 1.

Valve elliptical with broad ends. Length, 0.086 mm; breadth, 0.034. Costæ robust, 1.5 in 0.01 mm, covered with spines. Differs from the type in its perfect elliptical shape and the presence of spines. Uncommon.

SURIRELLA PANTOCSEKII Meister.

Surirella Pantocsekii MEISTER, Beiträge zur Bacillar. Japans. (1930) 230, pl. 8, figs. 14, 15.

Valve long-linear, gradually constricted in the middle and undulate at the ends. Length, 0.049 mm; breadth, 0.0085. Striæ 15 in 0.01 mm. Uncommon. Known from Tokyo and Kizaki Lake.

SURIRELLA TENERA Greg. var. NIPPONICA var. nov. Plate 4, fig. 1.

Differs from the type in its elongate valve, enlarged in one part, attenuate in another. Length, 0.127 mm; breadth, 0.02. Costæ 10 in 0.01 mm. Uncommon.

SURIRELLA BIWENSIS sp. nov. Plate 2, fig. 5; Plate 7, fig. 4.

Valve long-linear, constricted in the middle and slightly capitate, cuneate at the ends. Length, 0.087 to 0.2 mm; breadth, 0.013 to 0.018 in the middle, 0.022 at the ends. Costæ fine, 5 to 7 in 0.01 mm. A species related to *Surirella Alisoviana* Skv., from Hanka Lake, eastern Siberia.

SURIRELLA NIPPONICA Skvortzow. Plate 4, fig. 5.

Surirella nipponica SKVORTZOW, Diatoms Kizaki Lake (1936) pl. 8, fig. 17.

Valve lanceolate-elliptical, undulate in the middle, gradually attenuate at the ends. Length, 0.124 mm; breadth, 0.018. Costæ reaching the pseudoraphe. Marginal keel forming wings, or alæ, 2 in 0.01 mm. Striæ distinct, 24 in 0.01 mm. Very common. Known from Kizaki Lake.

SURIRELLA ELEGANS Ehr.

Surirella elegans Ehr., FR. HUSTEDT, Bacillar. (1930) 440, fig. 858.

Valve elongate-ovate. Length, 0.144 mm; breadth, 0.038. Common.

SURIRELLA ELEGANS Ehr. var. NORVEGICA (Eulenst.) Brun. fo. OBTUSA A. Mayer. Plate 3, fig. 5.

Surirella elegans Ehr. var. *norvegica* (Eulenst.) Brun. fo. *obtusa* A. MAYER, Bacillar. d. Regensburger Gewässer (1913) 344, pl. 23, fig. 1.

Valve linear-elliptical with rounded and obtuse ends. Length, 0.235 mm; breadth, 0.037. Costæ 2, striæ 40, in 0.01 mm. Common. Known from Europe.

SURIRELLA GRACILIS (W. Smith) Grun. fo. CURVATA fo. nov. Plate 3, fig. 19.

Valve linear-elliptical, irregularly curved. Length, 0.045 mm; breadth, 0.006. Costæ 8, striæ 24, in 0.01 mm. Uncommon.

SURIRELLA LINEARIS W. Smith var. CONSTRICTA (Ehr.) Grun.

Surirella linearis W. Smith var. *constricta* (Ehr.) Grun., Fr. Hustedt, Bacillar. (1930) 434, fig. 839.

Valve elliptical, constricted, attenuate at the ends. Length, 0.057 mm; breadth, 0.01. Common. Reported from Aokiko and Kizaki Lakes.

SURIRELLA OVATA Kütz. Plate 4, fig. 17.

Surirella ovata Kütz., Fr. Hustedt, Bacillar. (1930) 442, fig. 864.

Valve elongate-ovate, broad at one end and attenuate at the other. Length, 0.017 to 0.024 mm; breadth, 0.0068 to 0.0085. Costæ 4 to 8 in 0.01 mm. Common. Known from fresh and brackish water.

SURIRELLA OVATA Kütz. var. PINNATA (W. Smith). Plate 3, fig. 16.

Surirella ovata Kütz. var. *pinnata* (W. Smith), Fr. Hustedt, Bacillar. (1930) 442, fig. 865.

Valve linear-ovate with attenuate ends. Length, 0.035 mm; breadth, 0.0068. Costæ 7, striae 18, in 0.01 mm. Common.

ILLUSTRATIONS

Plate 1

Figs. 1 and 2. *Melosira solida* Eulenstein var. *nipponica* var. nov.
3 to 6. *Melosira solida* Eulenstein.
Fig. 7. *Melosira granulata* (Ehr.) Ralfs var. *angustissima* O. Müll.
Figs. 8 and 9. *Stephanodiscus carconensis* Grun. var. *pusilla* Grun.
Fig. 10. *Melosira solida* Eulenstein.
Figs. 11 to 13. *Stephanodiscus carconensis* Grun. var. *pusilla* Grun.
Fig. 14. *Stephanodiscus carconensis* Grun. var. *pusilla* Grun.?
15. *Cyclotella glomerata* Bachmann fo. *nipponica* Skv.
16. *Melosira americana* Kütz. fo. *nipponica* fo. nov.
17. *Melosira solida* Eulenstein.
18. *Stephanodiscus carconensis* Grun. var. *pusilla* Grun.
19. *Stephanodiscus carconensis* Grun.
20. *Melosira granulata* (Ehr.) Ralfs? var. *muzzanensis* (Meister) Bethge?
21. *Melosira solida* Eulenstein var. *nipponica* var. nov.
22. *Cyclotella comta* (Ehr.) Kütz. var. *oligactis* (Ehr.) Grun.
23. *Stephanodiscus carconensis* Grun.
24. *Melosira solida* Eulenstein.
25. *Synedra minuscula* Grun. var. *capitata* var. nov.
26. *Coscinodiscus lacustris* Grun. var. *nipponica* var. nov.
Figs. 27 and 28. *Stephanodiscus biwensis* sp. nov.

Plate 2

Fig. 1. *Navicula scutelloides* W. Sm.
2. *Navicula radiosa* Kütz. fo. *nipponica* fo. nov.
3. *Achnanthes Clevei* Grun.
4. *Synedra acus* Kütz.
5. *Surirella biwensis* sp. nov.
6. *Pinnularia gibba* Ehr. var. *biwensis* var. nov.
7. *Caloneis nipponica* sp. nov.
8. *Cymbella turgidula* Grun. var. *nipponica* var. nov.
9. *Caloneis bacillum* (Grun.) Meresch. var. *lancettula* (Schulz.) Hust.
10. *Navicula subhamulata* Grun.
11. *Epithemia sorex* Kütz. var. *gracilis* Hust.
12. *Neidium obliquestriatum* A. S.
13. *Gomphonema parvulum* (Kütz.) Grun. var. *exilissima* Grun.
14. *Rhoicosphenia curvata* (Kütz.) Grun.
15. *Eunotia sudetica* (O. Müll.) Hust. var. *nipponica* var. nov.
16. *Synedra Ulna* (Nitzsch) Ehr. var. *oxyrhynchus* (Kütz.) Van Heurck fo. *constricta* Hust.
17. *Gomphonema vastum* Hust. var. *elongata* Skv.

FIG. 18. *Navicula lanceolata* (Agardh) Kütz. var. *nipponica* var. nov.
19. *Gomphonema lingulatum* Hust. var. *pumila* var. nov.
20. *Pinnularia Braunii* (Grun.) Cleve var. *amphicephala* (A. Mayer) Hust. fo. *nipponica* fo. nov.
21. *Synedra parasitica* W. Smith.
22. *Navicula dicephala* (Ehr.) W. Smith. var. *neglecta* (Krasske) Cleve.
23. *Diploneis ovalis* (Hilse) Cleve var. *oblongella* (Naeg.) Cleve fo. *nipponica* fo. nov.
24. *Nitzschia tryblionella* Hantzsch var. *debilis* (Arnott) A. Mayer.

PLATE 3

FIG. 1. *Diploneis ovalis* (Hilse) Cleve var. *bipunctata* var. nov.
2. *Navicula similis* Krasske var. *nipponica* var. nov.
3. *Navicula falaisiensis* Grun. var. *nipponica* Skv.
4. *Gyrosigma Spencerii* (W. Smith) Cleve var. *nodifera* Grun.
5. *Surirella elegans* Ehr. var. *norvegica* (Eulenst.) Grun. fo. *obtusa* A. Mayer.
6. *Cymbella lata* Grun. var. *nipponica* var. nov.
7. *Synedra rumpens* Kütz. var. *fragilarioides* Grun. fo. *nipponica* fo. nov.
8. *Pinnularia nipponica* Skv.
9. *Caloneis nipponica* sp. nov.
10. *Epithemia turgida* (Ehr.) Kütz.
11. *Gomphonema lingulatum* Hust. var. *elongatum* var. nov.
12. *Gomphonema intricatum* Kütz. var. *pumila* Grun.
13. *Gomphonema lingulatum* Hust.
14. *Navicula rostellata* Kütz. var. *biwensis* var. nov.
15. *Neidium dubium* (Ehr.) Cleve fo. *constricta* Hust.
16. *Surirella ovata* Kütz. var. *pinnata* (W. Smith).
17. *Navicula minuta* sp. nov.
18. *Caloneis punctata* sp. nov.
19. *Surirella gracilis* (W. Smith) Grun. fo. *curvata* fo. nov.
20. *Navicula radiosa* Kütz. fo. *nipponica* fo. nov.

PLATE 4

FIG. 1. *Surirella tenera* Greg. var. *nipponica* var. nov.
2. *Navicula undulata* sp. nov.
3. *Diploneis marginestriata* Hust. var. *nipponica* var. nov.
4. *Cymbella turgidula* Grun. var. *nipponica* var. nov.
5. *Surirella nipponica* Skv.
6. *Gomphonema lanceolatum* Ehr. var. *insignis* (Greg.) Cleve.
7. *Navicula menisculus* Schum.
8. *Navicula peregrina* (Ehr.) Kütz. var. *nipponica* var. nov.
9. *Navicula tuscula* (Ehr.) Grun. var. *densistriata* var. nov.
10. *Navicula mutica* Kütz. var. *nipponica* var. nov.
11. *Diploneis ovalis* (Hilse) Cleve var. *nipponica* var. nov.
12. *Pinnularia undulata* Greg. var. *nipponica* var. nov.
13. *Synedra nipponica* Skv.
14. *Frustulia rhomboides* (Ehr.) de Toni var. *saxonica* (Rabh.) de Toni fo. *nipponica* fo. nov.

FIG. 15. *Caloneis nipponica* sp. nov.
16. *Cocconeis disculus* Schum. var. *nipponica* var. nov.
17. *Surirella ovata* Kütz.

PLATE 5

FIG. 1. *Surirella robusta* Ehr. var. *nipponica* var. nov.
2. *Pinnularia gibba* Ehr.
3. *Pinnularia Braunii* (Grun.) Cleve var. *nipponica* var. nov.
4. *Nitzschia acuta* Hantzsch.
5. *Achnanthes Clevei* Grun. var. *nipponica* Skv.
6. *Pinnularia striatula* sp. nov.
7. *Stauroneis Smithii* Grun. var. *rhombica* Meister.
8. *Navicula soodensis* Krasske.
9. *Nitzschia Lorenziana* Grun. var. *subtilis* Grun.
10. *Navicula Kawamuræ* sp. nov.
11. *Navicula subhamulata* Grun. var. *parallela* var. nov.
12. *Navicula costulata* Grun. var. *nipponica* var. nov.
13. *Navicula costulata* Grun. fo. *curta* fo. nov.
14. *Achnanthes Biasolettiana* Kütz.
15. *Attheya Zachariasi* Brun.
16. *Navicula costulata* Grun. var. *tenuirostris* var. nov.
17. *Navicula Nippon* sp. nov.
18. *Achnanthes affinis* Grun.
19. *Diploneis ovalis* (Hilse) Cleve var. *oblongella* (Naegeli) Cleve.
20. *Cymbella nipponica* sp. nov.
21. *Synedra nana* Meister var. *nipponica* Skv.
22. *Gomphonema Berggrenii* Cleve.
23. *Cymbella nipponica* sp. nov.

PLATE 6

FIG. 1. *Coscinodiscus lacustris* Grun. var. *nipponica* var. nov.
2. *Stephanodiscus carconensis* Grun. Anomaly.
3. *Pinnularia polyonca* (Breb.) O. Müll. var. *nipponica* var. nov.
FIGS. 4 and 5. *Eucocconeis onegensis* Wisl. and Kolbe.
FIG. 6. *Frustulia vulgaris* Thwait. var. *asiatica* Skv.
7. *Amphora ovalis* Kütz. var. *libyca* (Ehr.) Cleve.
8. *Pinnularia Lacus Biwa* sp. nov.
9. *Caloneis silicula* Ehr. var. *baicalensis* Skv. and Mayer.
10. *Pinnularia viridis* (Nitzsch) Ehr. var. *leptogongyla* (Ehr.? Grun.) Cleve.
11. *Nitzschia tryblionella* Hantz. var. *victoriæ* Grun.
12. *Achnanthes Hauckiana* Grun. var. *nipponica* var. nov.
13. *Navicula menisculus* Schum.
14. *Synedra Ulna* (Nitzsch) Ehr. var. *Ramesi* (Herib. and Peragallo) Hust.
15. *Navicula Lambda* Cleve var. *nipponica* var. nov.
16. *Gomphonema lingulatum* Hust.

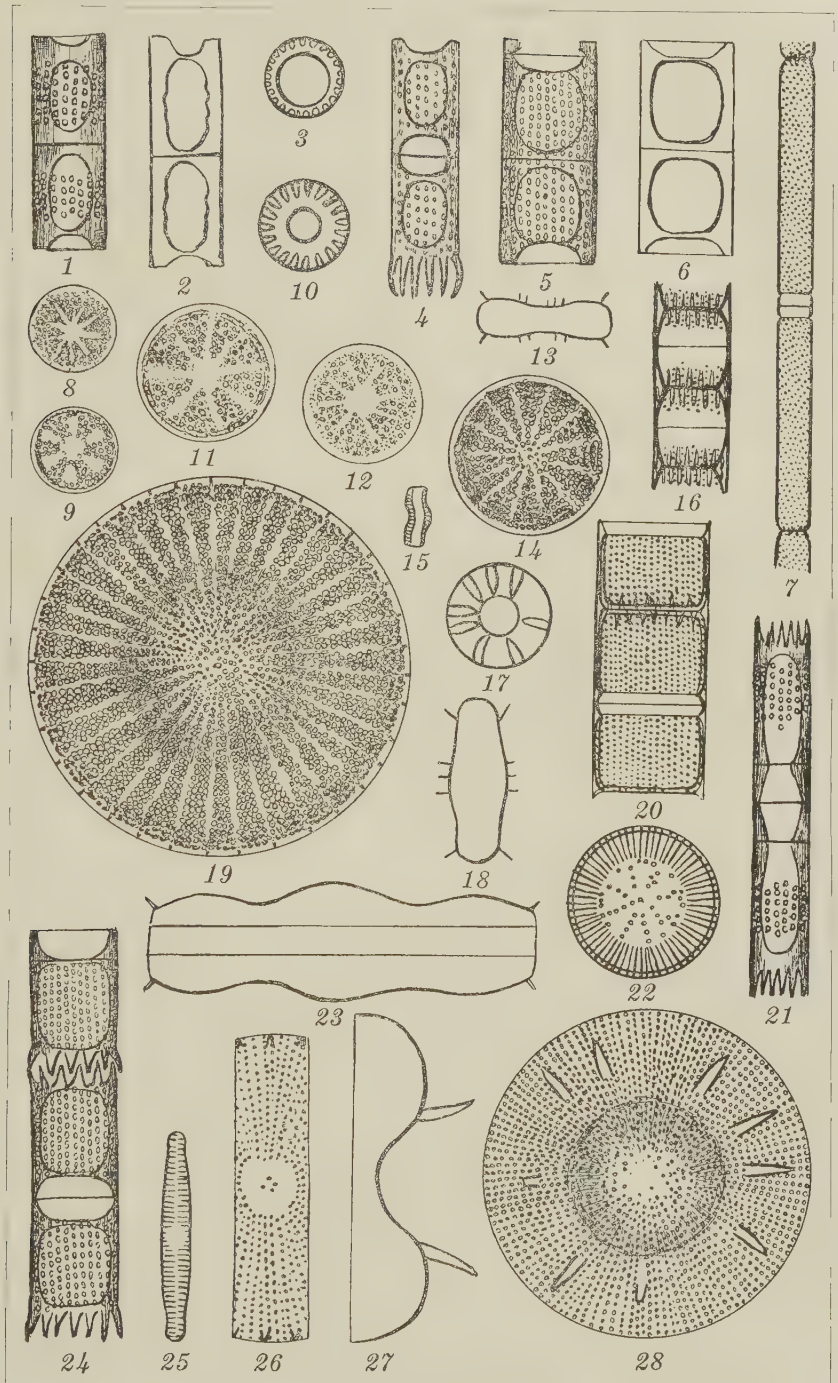
PLATE 7

FIG. 1. *Gyrosigma attenuatum* (Kütz.) Rabh. var. *nipponica* var. nov.
2. *Rhoicosphenia curvata* (Kütz.) Grun. var. *major* Cleve.

FIG. 3. *Pinnularia platycephala* Cleve var. *Hattoriana* Meister fo. *angustior* fo. nov.
4. *Surirella biwensis* sp. nov.
5. *Navicula lanceolata* (Agardh) Kütz. var. *nipponica* var. nov.
6. *Navicula undulata* sp. nov.
7. *Navicula placentula* (Ehr.) Grun.
8. *Navicula achnanthoides* sp. nov.
9. *Navicula hasta* Pant. var. *gracilis* var. nov.
10. *Nitzschia Clausii* Hantzsch.
11. *Caloneis bacillum* (Grun.) Meresch. var. *lancettula* (Schulz.) Hust. fo. *densistriata* fo. nov.
12. *Pinnularia Kawamuræ* sp. nov.

PLATE 8

FIG. 1. *Neidium obliquestriatum* A. S. var. *elongata* var. nov.
2. *Pinnularia undulata* Greg. var. *nipponica* var. nov.
3. *Pinnularia cucumis* sp. nov.
4. *Pinnularia Nakaii* sp. nov.
5. *Pinnularia nipponica* Skv.
6. *Pinnularia major* (Kütz.) Cleve var. *nipponica* var. nov.
7. *Gomphonema vastum* Hust. var. *maxima* var. nov.
8. *Navicula gastrum* Ehr. fo. *nipponica* fo. nov.
9. *Navicula crucicula* (W. Smith) Donk. var. *obtusata* Grun.
10. *Didymosphenia geminata* (Lyngb.) M. Schmidt.
11. *Pinnularia viridis* (Nitzsch) Ehr. var. *fallax* Cleve.
12. *Eunotia gracilis* (Ehr.) Rabh.
13. *Eunotia prærupta* Ehr. var. *bidens* Grun.



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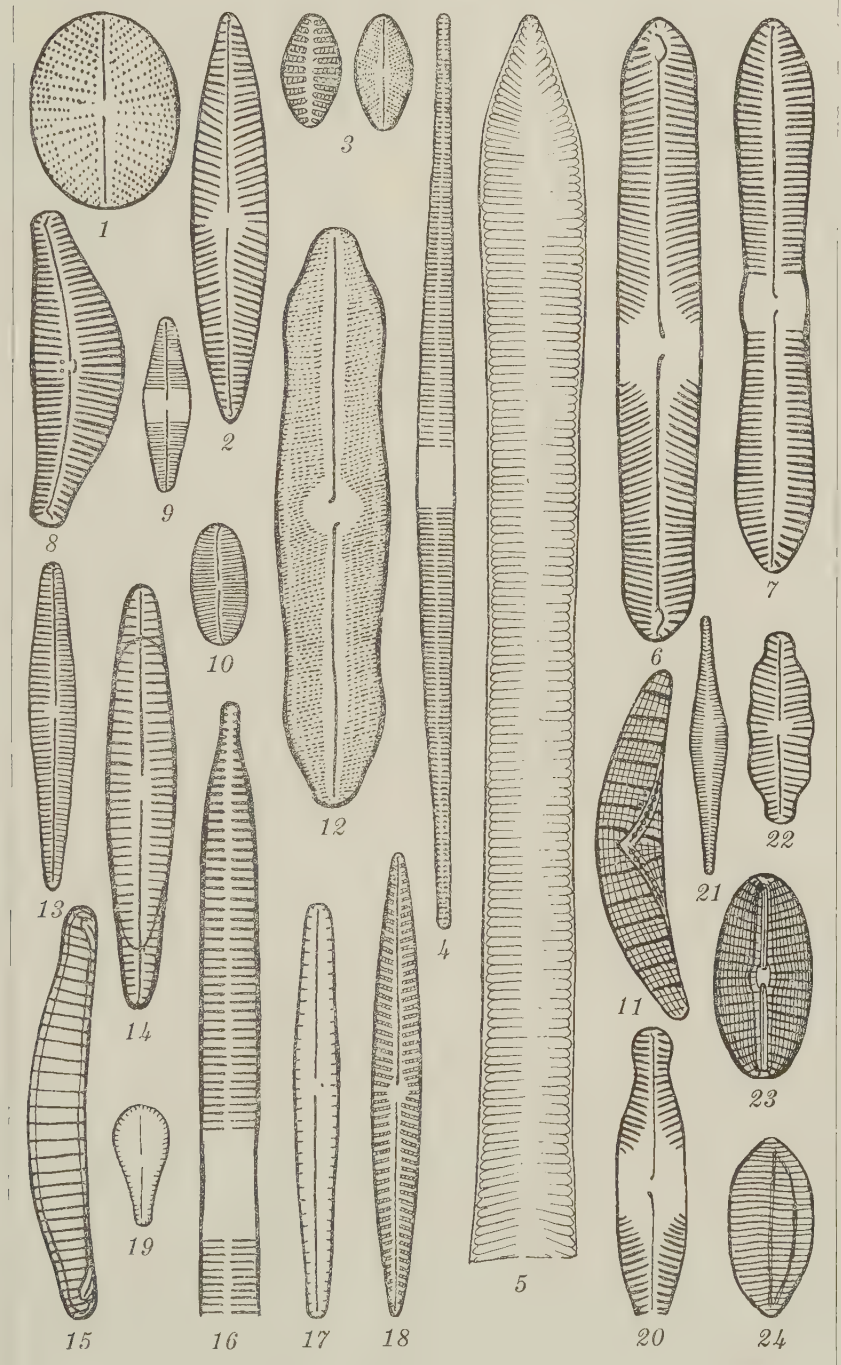

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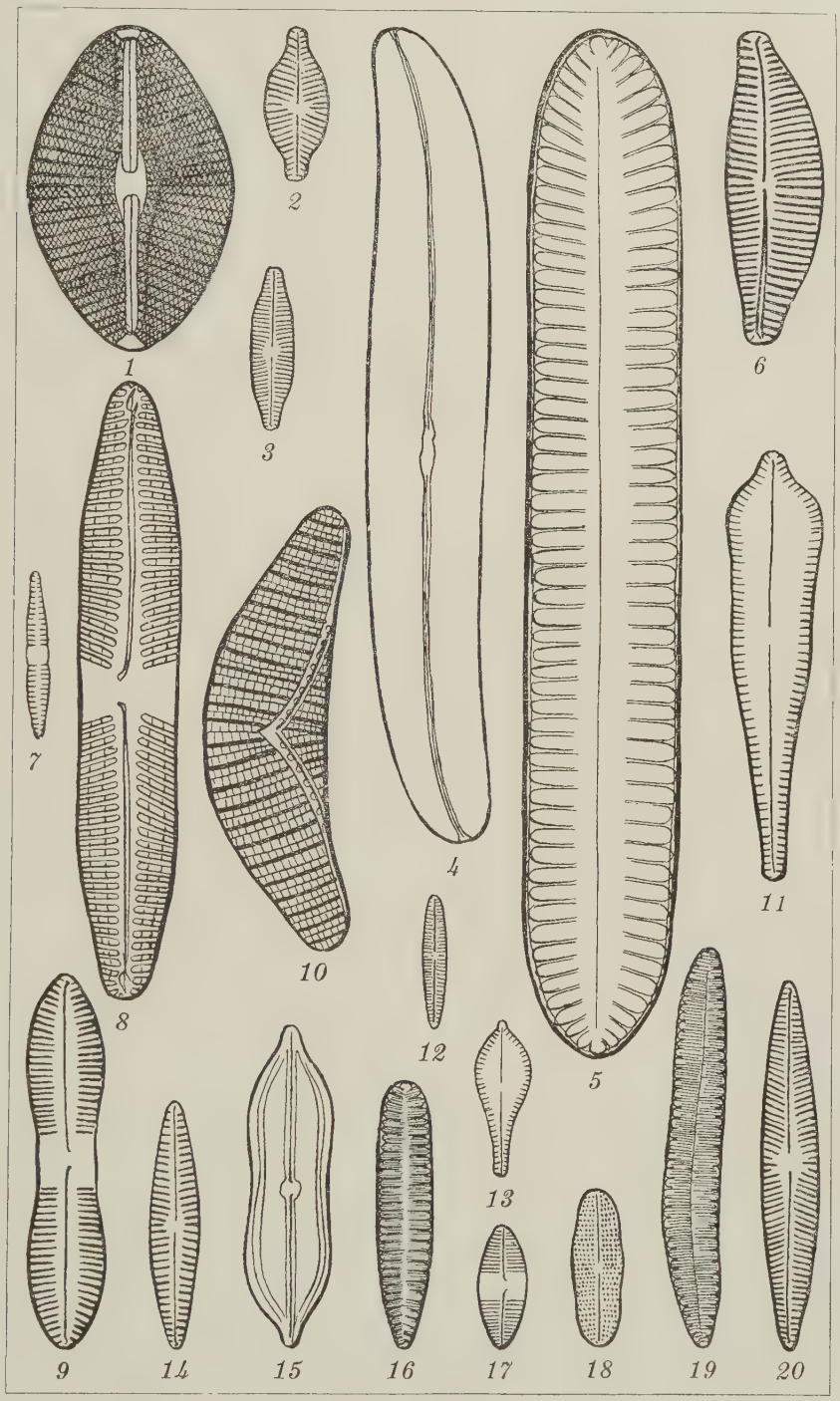

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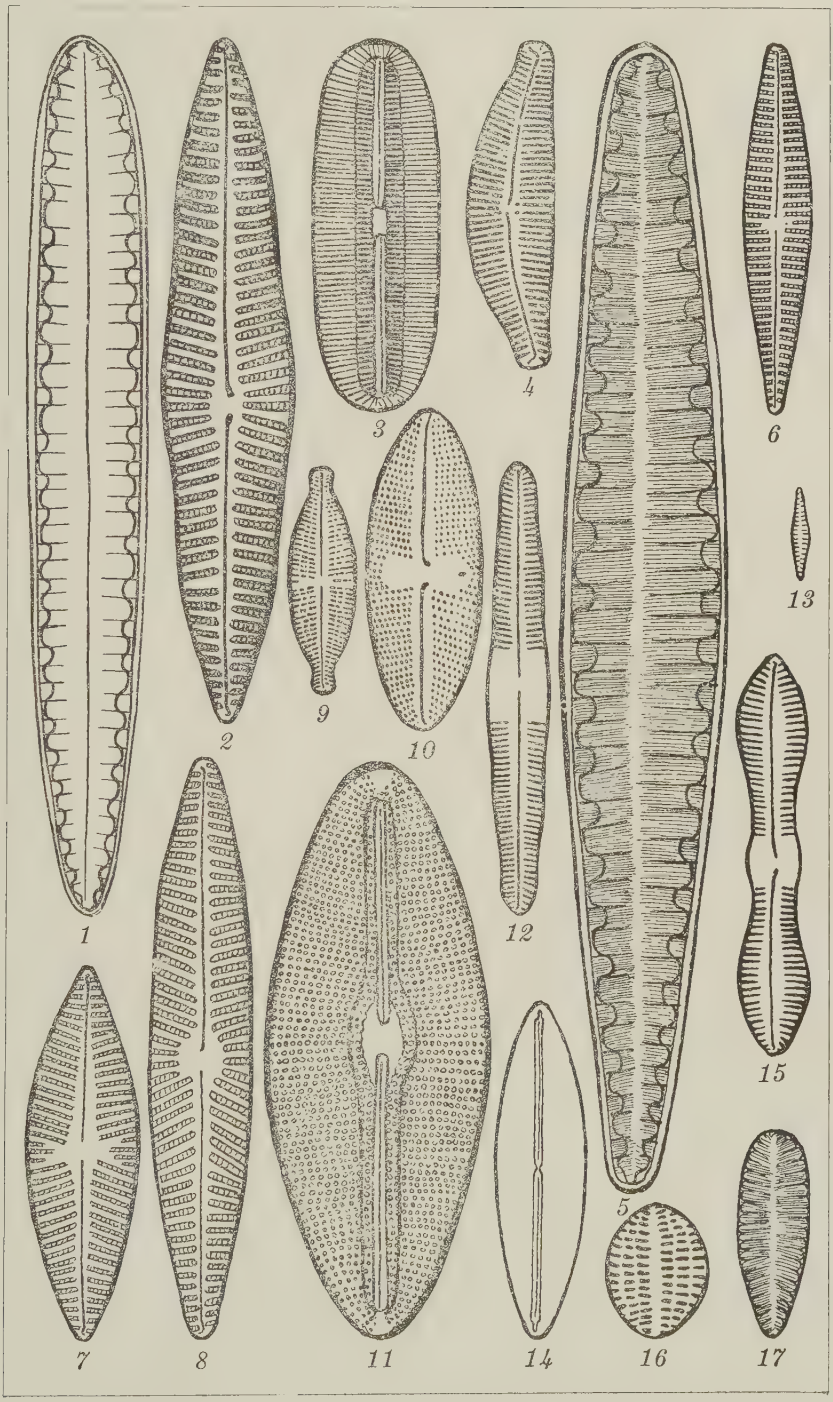

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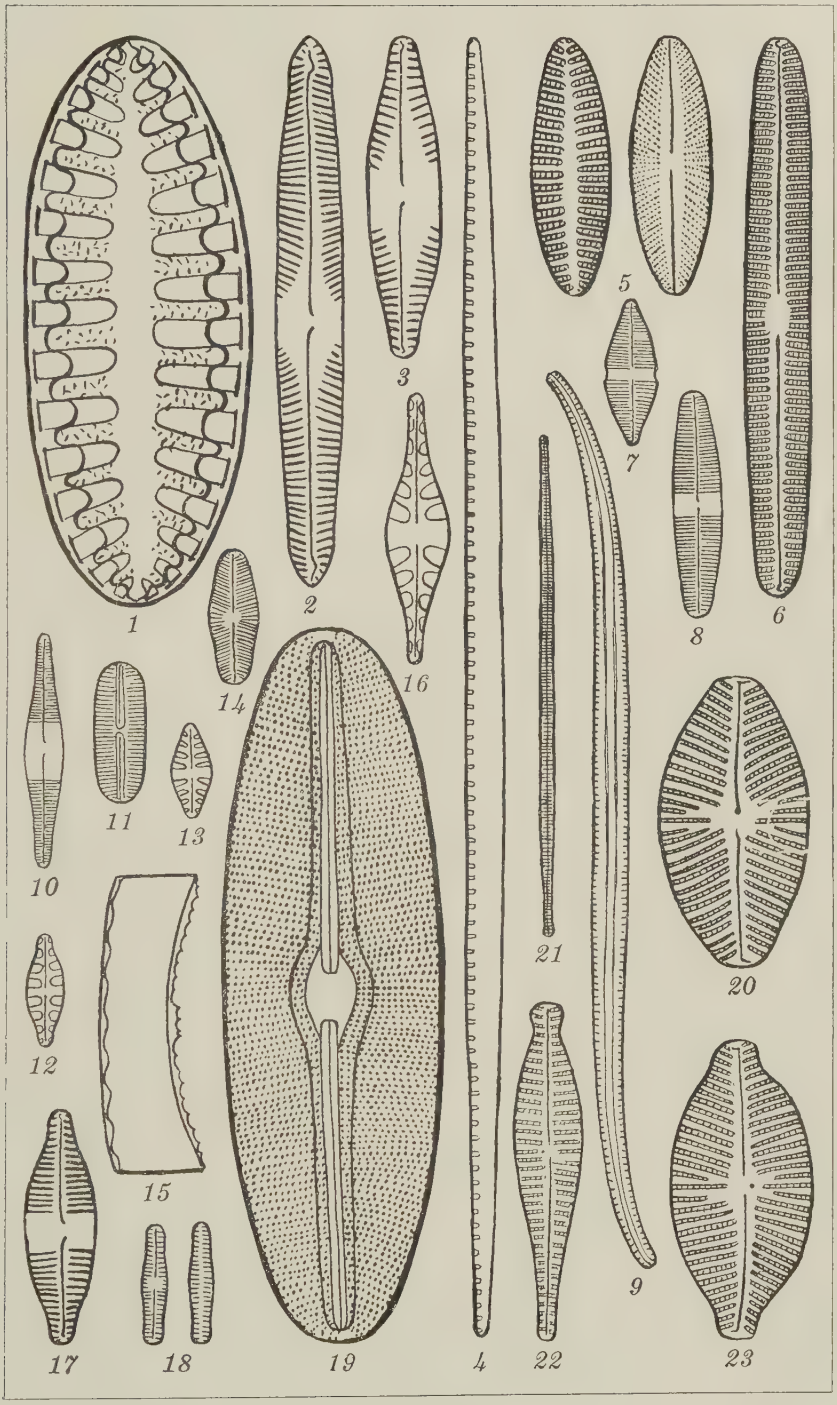

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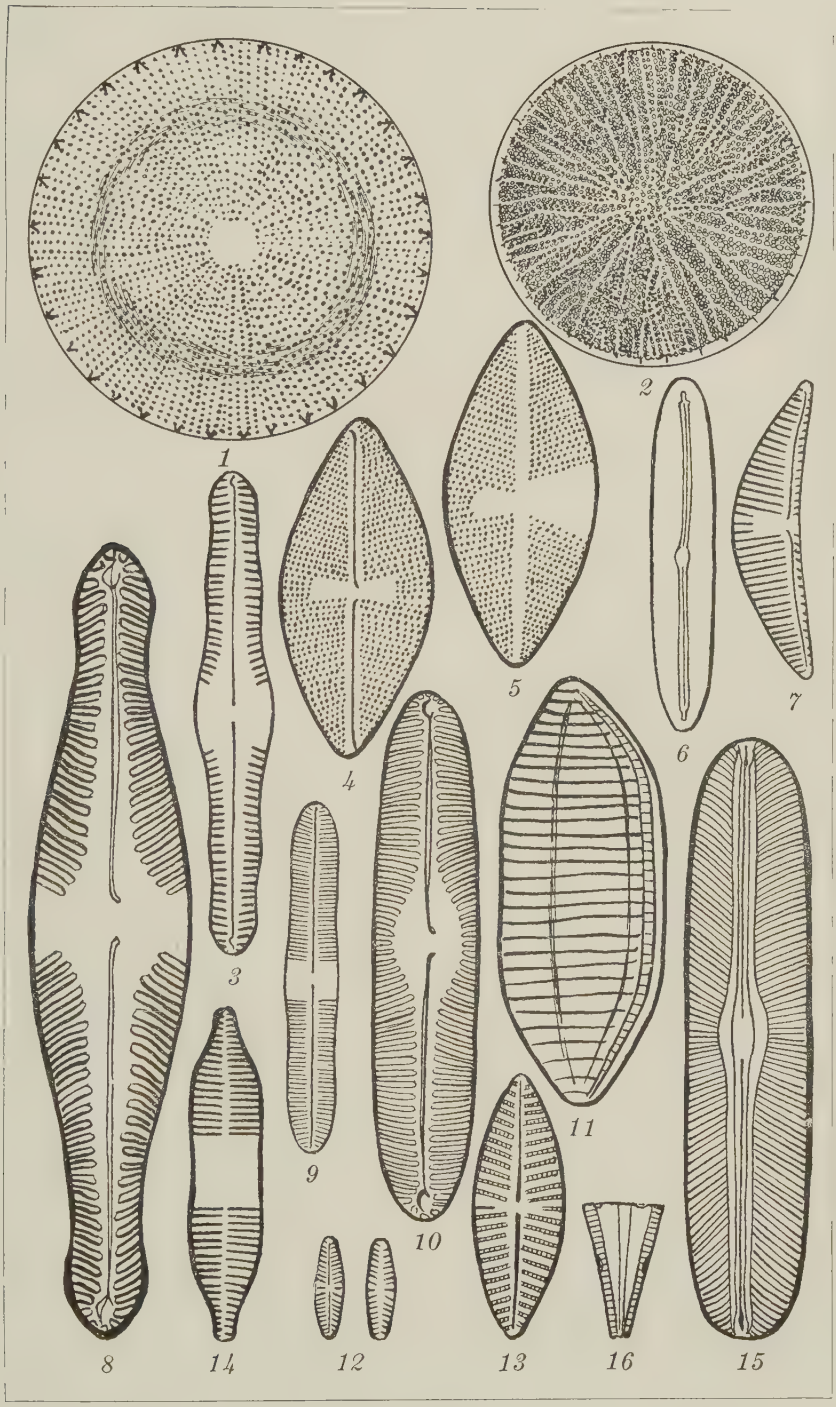

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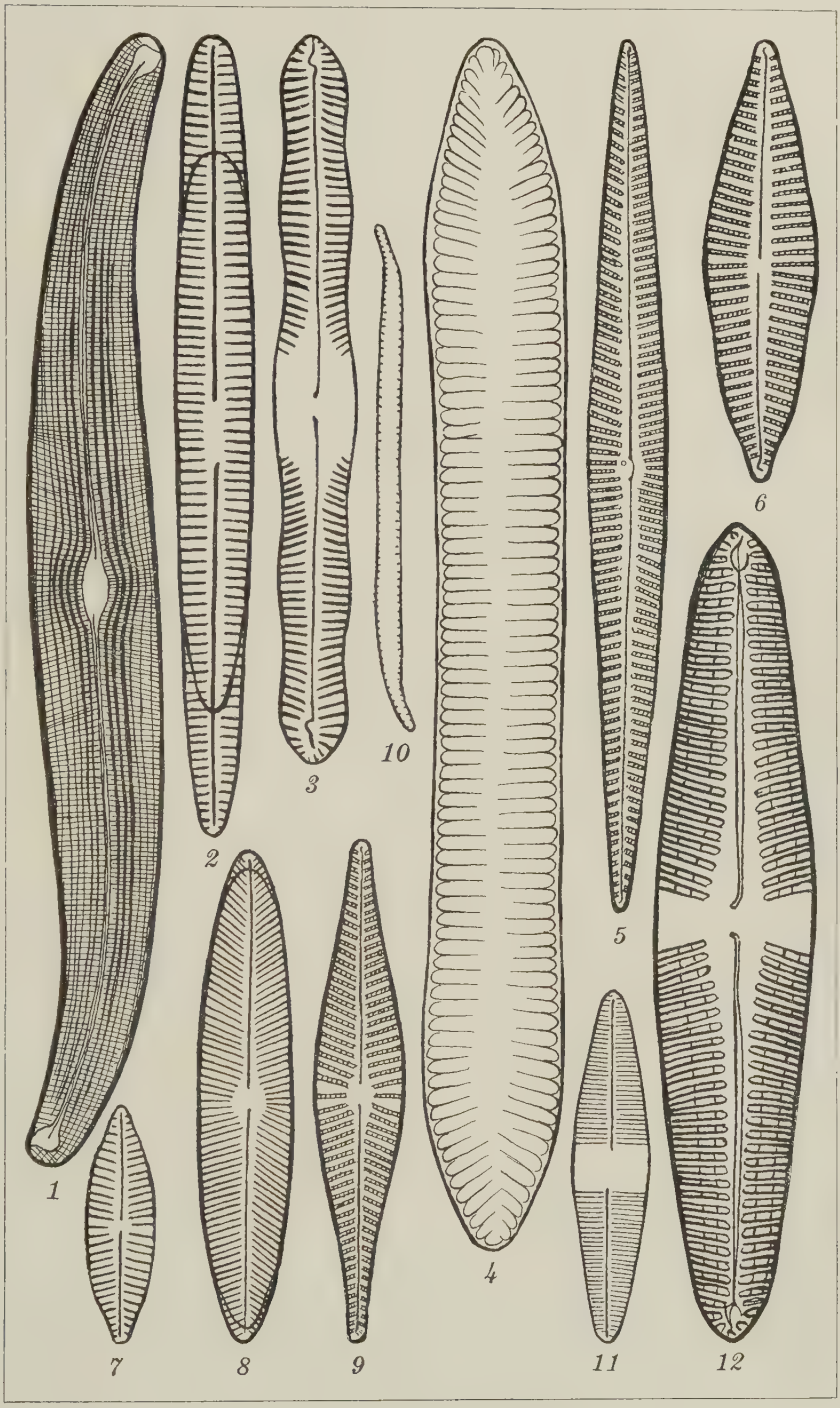

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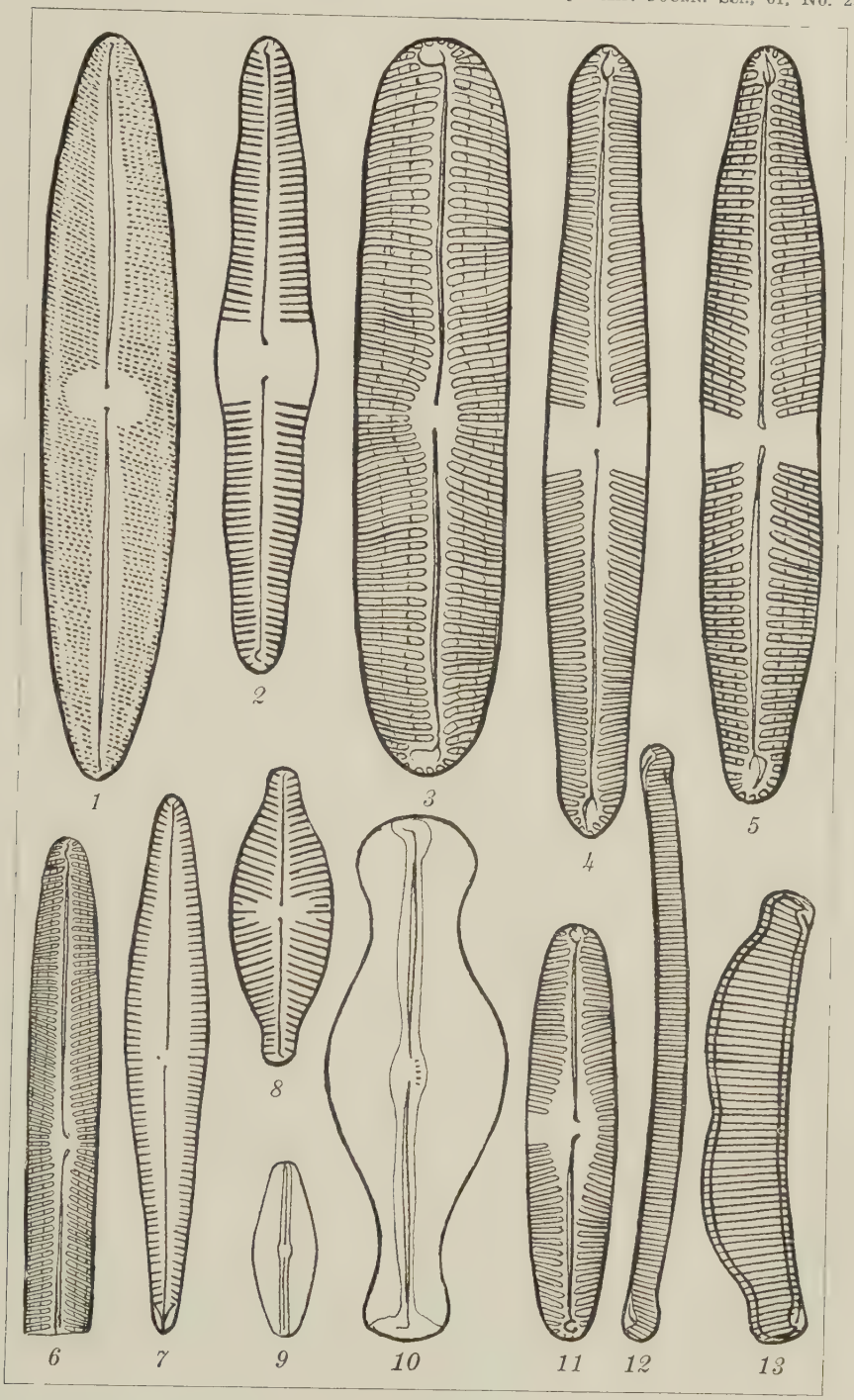

PLATE 8.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

RECEIVED

American society for testing materials. Committee D–13 on textile materials. A. S. T. M. standards on textile materials. Philadelphia, Pa., 1935. 246 pp., illus. Price, paper, $1.50.

ANDREWS, ANDREW I. Enamels: the preparation, application, and properties of vitreous enamels. 1st ed. Champaign, Ill., The Twin city printing co., 1935. xviii + 410 pp., illus. Price, $5.50.

BAKER, JOHN R. Cytological technique. London, Methuen & co., 1933. xi + 131 pp., illus.

BROMLEY, DOROTHY DUNBAR. Birth control: its use and misuse. With an introduction by Robert Latou Dickinson. New York and London, Harper & brothers, 1934. xxii + 304 pp. Price, $2.50.

BUEHLER, E. C., comp. and ed. Free medical care: socialized medicine. New York, Noble & Noble, 1935. Price, $2.

DEMPWOLFF, OTTO. Vergleichende lautlehre des austronesischen wortschatzes, I. Berlin, D. Reimer, 1934. (Zeitschrift für eingeborenensprachen. Beihefte 15.) 124 pp. Price, $3.25.

DUGDALE, J. N. Health in hot climates. 2d ed. London, John Bale sons & Danielsson, 1931. 189 pp. Price, $1.25.

GHOSH, DIRENDRA NATH. A treatise on hygiene and public health, with special reference to the tropics. Rev. and largely rewritten with the assistance of A. D. Stewart. 8th ed. Calcutta, Scientific publishing co., 1935. xv + 660 pp., illus. Price, $3.25.

GRAUBARD, MARK. Genetics and the social order. New York city, Tomorrow publishers, 1935. 127 pp., 14 diagrs. Price, paper, $0.50; cloth, $0.75.

HEISE, FRED H., ed. 1000 questions and answers on T. B. New York, Journal of the outdoor life, 1935. vi + 232 pp. Price, $0.75.

HOTTES, ALFRED CARL. 1001 Garden questions answered. New York, A. T. De La Mare company, 1935. ix + 320 pp., illus. Price, $2.

HOWARD, LOUISE E. Labour in agriculture: an international survey. London, Oxford university press, 1935. xiv + 339 pp. Price, $7.

ILLICK, JOSEPH S. An outline of general forestry. N. Y., Barnes & Noble [c. 1935]. 259 pp., illus. Price, $1.50.

JOHNSTONE, JAMES. The marine plankton; with special reference to investigations made at Port Erin, Isle of Man, during 1907–1914. A handbook for students and amateur workers, by James Johnstone, and

Andrew Scott and Herbert C. Chadwick, with an introduction by Sir William A. Herdman. Third reprint. London, The University press of Liverpool [etc.] 1934. xvi + 194 pp., illus. Price, $3.25.

KILPATRICK, WILLIAM. Sugar factories and sugar machinery. London, The Institution of mechanical engineers, 1933. 70 pp., illus.

LANGEN, C. D. DE, and A. LICHTENSTEIN. A clinical textbook of tropical medicine. 1st Eng. ed. from the rev. 3d Dutch ed. Batavia (etc.), G. Kolff & co., 1936. xi+ 537 pp., xiii–xxxv., illus.

LUTHRINGER, GEORGE F. The gold-exchange standard in the Philippines. Princeton, Princeton university press, 1934. xvi + 291 pp., tables, diagrs. Price, $3.

MCGUIRE, CHRISTIE. Ulcers in the tea-gardens. Calcutta, The Catholic orphan press, 1934. Cover title, 16 pp., plates.

MARSHALL, C. E. Colloids in agriculture. London, Edward Arnold & co., 1935. vii + 184 pp., illus. Price 5/-.

MERRILL, ELMER DREW. An enumeration of plants collected in Sumatra by W. N. and C. M. Bangham, by Elmer Drew Merrill. Jamaica Plain, Mass., The Arnold arboretum of Harvard university, 1934. 178 pp., illus. Price, $2.50.

NEELY, WAYNE CALDWELL. The Agricultural fair. New York, Columbia university press., 1935. xii + 313 pp., illus. Price, $3.75.

PEYRE, EDOUARD. Manuel de sérologie pratique. Paris, Librairie Felix Alcan, 1935. xxiii + 267 pp., tables. Price, $1.

RICHMOND, WINIFRED V. An introduction to sex education. New York, Farrar & Rinehart [c. 1934]. xiv + 312 pp., illus. Price, $2.50.

ROHRER, CALEB WYAND GEETING. Researches in cancer: part one, 1896–1921; 1922–1932. Baltimore, The Brentwood printing company, 1934. 144 pp., illus. Price, $3.50.

SEDGWICK, WILLIAM THOMPSON. Sedgwick's principles of sanitary science and public health, rewritten and enl. by Samuel C. Prescott and Murray P. Horwood. New York, The Macmillan company, 1935. xviii + 654 pp., tables. Price, $4.25.

SIEGEL, MORRIS. Constructive eugenics and rational marriage. Toronto, McClelland & Stewart [c. 1934]. xiii + 196 pp., illus.

SMALL, VICTOR R. I knew 3000 lunatics. New York, Farrar & Rinehart [c. 1935] vii + 273 pp. Price, $2.50.

SMITH, JAMES GERALD. Economic planning and the tariff; an essay on social philosophy. Princeton, Princeton university press, 1934. x + 331 pp. Price, $3.

SPICER, E. H. The endotoxic infections and their control with edwenil. 5th ed. rev. Watford, Herts., E. H. Spicer & co., 1935. 141 pp.

TILDEN, JOSEPHINE E. The algæ and their life relations; fundamentals of phycology. Minneapolis, Minn., University of Minnesota press, 1935. xii +550 pp., illus. Price, $5.

Union of Soviet Socialist Republics. State planning commission of the council of peoples commissars. Summary of the fulfillment of the first five-year plan for the development of the national economy of the U. S. S. R. Report. 2d rev. ed. New York, International publishers, 1933. 304 pp. Price, $1.25.

REVIEWS

Garden Flowers in Color; a Picture Cyclopedia of Flowers. By Glendon A. Stevens. The Macmillan Company, New York, 1934. 320 pp., col. illus. Price, $3.75.

This is a unique book on ornamentals. The author acknowledges that it has been written for the most part from actual garden acquaintance with the wide range of flowers described in it. He claims that in so doing his purpose is to provide "a book of definite educational value as well as a convenient garden adjunct." To see how far in each case the book meets his expectations, one needs only to glance at the assembly of over 300 garden flowers illustrated with much fidelity in their natural colors with beautiful photographic plates. These illustrations, which are enough to make one welcome the book, will show many an inexperienced gardener just what most garden blooms look like. Each illustration is accompanied by a brief account of the habits of the plants, their use, and cultivation. This is an added feature which makes the book doubly useful as a dependable guide to garden flowers. The descriptions are brief and include the scientific names of the flowers.

The arrangement is alphabetical, but individual plants are better located by consulting the index.—E. Q.

Economic Geography of Asia. By Daniel R. Bergsmark. Prentice-Hall, Inc., New York, 1935. 618 pp., illus., diagrs., maps. Price, $5.

While a few good books on Asia have already been published, Bergsmark's technic meets ideally the average requirements of a college textbook on Asia. His is always on the alert, evaluating the mutual relationships which may be established between man's manifold activities in his effort to earn his living and the natural environmental complex, thus eliminating unessentials and irrelevant subject matter.

The illustrations, graphs, diagrams, and maps are illuminating, but there are many typographical errors, a few of which are the following: Page 24, Rea Sea; page 72, 9th and 10th lines, of of; page 114, antonomous states; page 210, last line of 3rd paragraph, the the; page 424, coking goal; page 427, potassium iodine.

There are some statements which need to be corrected or improved, such as that on page 27, "In the Philippines, thousands of miles of terraces extend throughout various parts of the ar-

chipelago." Such terraces are only found in the Mountain Province, Luzon, and not throughout the various parts of the Archipelago. On page 69, "While Asia adds but little to the total amounts of coal and iron ore of the commercial world, it does contribute large percentages of the world's tin, antimony, tungsten, graphite and emory." Why not list also copper and gold? Japan is one of the ranking copper producers and so are Manchukuo, Chosen, Taiwan, China, and the Philippines for gold.

The inclusion of Cultural, Religious, and Linguistic Diversity on page 179 under chapter XI, the Natural Environment of India, may lead an unwary student to an erroneous concept of natural environment.

On page 347, "Rice . . .; and the highest yields per acre are obtained in the Candaba Swamp . . ." The Candaba Swamp proper does not produce rice; it is a reserved area for wild life such as birds and fishes. The immediate surrounding land which may have been reclaimed from the original swampy area certainly is not the highest yielder of rice per unit area, but Nueva Ecija, a province in Central Luzon.

Notwithstanding these minor observations, the reviewer considers Bergsmark's Economic Geography of Asia as interestingly readable to the layman; well-suited to college students pursuing a course on Asia; and thought-provoking to teachers, well worth the price of the book.—C. C. C.

Marine Boring Animals Injurious to Submerged Structures. By W. T. Calman. Second edition rev. by G. I. Crawford. British Museum (Natural History) Economic Series No. 10. The British Museum, London, 1936. 38 pp., illus. Price, $0.25.

This pamphlet is a valuable contribution on the subject of marine boring animals and the destructive effect they may have on submerged structures. It sums up our present-day knowledge of the natural history of the animals concerned and offers significant details which are useful both to zoölogists and to marine engineers who are interested in the practical application of the facts recorded.

The pamphlet is well illustrated. A list of the most important titles is given to provide guidance for those who wish to pursue the subject further.—F. T.

Wistar Institute Style Brief. Prepared by the coöperative efforts of the editors of journals published by the Wistar Institute and the staff of the Wistar Institute Press. The Wistar Institute Press, Philadelphia, 1934. 169 pp., illus., plates. Price, $2.

This handbook is a concise answer to the long-felt need for a style guide especially designed to meet the problems of the technical and scientific writer. Principles that scientific writers and editors have so far had to evolve laboriously for themselves from experience and continual groping after what is common sense, are here laid down in simple and direct form, so as to be available to the consultant at a moment's notice.

While the purpose of this little book is largely to explain Wistar Institute methods to biological writers, and to promote coöperation between author and editor, it cannot fail to be extremely welcomed to those interested in the writing and publication of scientific and technical papers in general, as the suggestions it contains, except as pertaining to matters of practice with regard to which even the best printing offices are at variance, apply to technical writing in any field.

Writers of scientific papers who hitherto felt that there is a definite technic to be acquired about the preparation of papers for publication, have had to rely on books of such general scope as the Style Manual of the United States Printing Office, and other first rate desk books that do have great practical utility and go into some detail in specialized fields, but are inadequate as sole reference books on the many crotchety problems confronting the technical writer. The Wistar Institute style book, though not as detailed, offsets these shortcomings of the general desk book, and can be used with equal profit either as a supplementary reference guide or independently.

One gratefully notices that, as far as scientific papers are concerned, the authors have regarded no problem as too trivial or too complex to come within the scope of the book. Choice of paper, margins, and pagination are given as definite treatment as reference lists and the most suitable method of preparing illustrations under different technical and financial conditions.

Intelligent use of this style brief will save the author considerable misdirected effort; even the seasoned author will find

it a profitable means of clarifying and confirming rules that he has built up in the course of time out of his own experience. The new author will find the brief, direct discussion of what constitutes a well-prepared technical paper invaluable.—S. R.

Electrons (+ and −), Protons, Photons, Neutrons, and Cosmic Rays. By Robert A. Millikan. (The University of Chicago Science Series.) The University of Chicago Press, Chicago, Illinois, 1935. 492 pp., illus. Price, $3.50.

This volume is the answer to the scientist's prayer for a clearer conception of modern physics, in which the author, whose works are widely used not only in America but also in other countries, presents some of the newer developments in the field with which he has closely associated his own work. These are the recent researches on the wave nature of the electron, the spinning electron, the positron, the neutron, transmutation of the elements and cosmic rays. Although by weaving the discussion around these subjects the author makes the book interesting, the general reader will find certain chapters the understanding of which requires more than a background of physics. Except for this requirement, any reader with scanty technical training may still get a lot of valuable information on the fascinating progress of modern physics described in this book.

—J. C. E.

Reproduction, Heredity and the Development of Sex. By H. G. Wells, Julian Huxley [and] G. P. Wells. Cassell & Company, Ltd., London, etc., 1935. 222 pp., 40 figs. Price, $1.

This small volume is the fourth in "The Science of Life" series, somewhat enlarged and brought up to date. Beginning with a discussion of the primitive types of reproduction which may be considered a special type of growth accompanied by detachment of daughter organisms, the authors arrive at the conclusion that sex is not reproductive. Sex is essentially anti-reproductive, inasmuch as the daughter organisms are not, so to say, chips of the old block, but the result of the interaction of the germinal substances carried by the sex cells from the two parents, who contribute equal amounts of the hereditary material. In this fact lies the means by which variations are reshuffled and recombined among the members of the species. How these variations are transmitted to the offspring is considered in a chapter in which the high lights of genetic knowledge are discussed. An attempt is also made to correlate genetics with embryology, but the result is vague due mainly to the

paucity of data along this line. Finally the authors give a summary of the chromosome theory of sex determination. No bibliography is included, but a good index is given.—A. R.

Practical Infra-Red Photography. By Othmar Helwich. A translation by J. L. Baring from the German of "Die Infrarot-Fotografie." The Fountain Press, 19 Cursitor Street, E. C. 4, London. [No date] illus. Price, $1.

Infra-red photography is a phase of photographic technic that has been developed within the last few years. In this book Othmar Helwich outlines its essential principles and describes its possible applications in various fields.

Nowhere is the infra-red plate more useful than in scientific photography, and the author bares its special adaptability in medicine, astronomy, criminology, and photomicrography. That it is also useful in photographing old documents, reproducing faded manuscripts, and testing fabrics is likewise shown by him.

Insofar as it instructs the amateur as well as the professional photographer and the scientist regarding the nature of infra-red photography, this book is valuable.—C. S. A.

Oxygen and Carbon Dioxide Therapy. By Argyll Campbell and E. P. Poulton. Foreword by Sir Leonard Hill. Oxford University Press: Humphrey Milford, London, 1934. 179 pp., illus. Price, 12s. 6d.

The mass of information scattered in scientific literature and the results of the extensive research and clinical observations of the authors are combined to form the basis of the present book.

Oxygen therapy has now become the established treatment for pneumonia and other pulmonary conditions, certain cases of cardiac failure, and carbon monoxide poisoning. For efficient treatment of these conditions a suitable apparatus is necessary. In this book the authors describe fully the different methods of giving oxygen treatment efficiently. A breathing mask or an intranasal tube must be used, or the patient be put in an oxygen chamber or oxygen tent. For this purpose the use of such apparatus as Bragg's and Drinker's for giving continuous respiration is described.

The treatise is divided into nine chapters, at the end of which is a summary for the sake of readers who may not have the time to weigh the whole of the evidence. It is also supplied with an adequate bibliography.

To practitioners and hospital directors, especially in the Philippines where the old clinical method of administration is still in vogue, in order to give them an insight of the modern methods of oxygen administration, this book is recommended.—I. C.

Human Sterilization To-day; a Survey of the Present Position. By Cora B. S. Hodson. Watts & Co., London, 1934. 55 pp. Price, $0.50.

One drawback to the book is the small print, which makes it difficult to read. However, it is an interesting collation of the scientific and experimental work on sterilization hitherto done in America and Europe. It presents beneficial results which should be wisely considered by all economists, eugenists, and political and social workers, as well as by officials of penal and psychopathic institutions. The application of sterilization in the Philippines as a means of improving the race and as a preventive measure in limiting hereditary, mental, and physical disabilities should be food for serious thought among progressive thinking Filipinos.—U. D. M.

Applied Silviculture in the United States. By R. H. Westveld. Edward Bros., Inc., Ann Arbor, Michigan, 1935. 416 pp., illus.

This publication on regional silviculture in the United States brings together the results of various studies made by the author, the Forest Service, experiment stations, and forest schools. Eighteen forest regions, eight in the western, nine in the eastern part of the United States, and one in Alaska, are thoroughly discussed under the main headings of Description, Historical, Ecological Basis for Silvicultural Practice, Economic Basis for Silviculture Practice, and the Application of Silviculture. Each chapter has been submitted for review to one or more authorities in the region to which the chapter applies so that the book may be considered authoritative. The book gives the reader a good idea of the physical and economic limitations, the present condition, and the modifications or improvements that must be developed in each of the forest regions.

The book is lithoprinted in two-column style and is well illustrated with photographs. There is a list of references at the end of each chapter and an index to the whole book. An appendix gives the common and scientific names of trees.—C. S.

Sex Behavior in Marriage. By Charles A. Clinton. Pioneer Publication, Inc., 1270 Sixth Ave., Radio City, N. Y., 1935. 159 pp., illus. Price, $2.

This book is excellent for the layman, but rather elementary for the physician. The anatomy and physiology of sex are explained in simple terms. The facts of life are explained to prospective newlyweds in a way to avoid shocking the sensitive. The facts dealing with the psychology of coitus and its proper performance may train prospective mates to avoid various pit-

falls that otherwise might cause marital unhappiness. It will enable parents to safeguard their children from half-truths gleaned furtively from unreliable sources.—B. M.

Race Differences. By Otto Klinberg. Harper & Brothers, Publishers, New York and London, 1935. 367 pp. Price, $2.50.

This book discusses race differences from three distinct approaches; namely, biological, psychological, and cultural. The author states that there is no racial hierarchy that is consistently supported by all the available evidence, and that the notion that one race is more primitive than another has no acceptable scientific foundation. He also states that he has carefully evaluated the theories on psychological race differences and has found them to have no basis in the study of physical characteristics, endocrine glands, blood, or brain; or in tests of sensory capacity, intelligence, or personality; or in the analysis of criminal statistics. He has further analyzed the relation between culture and psychology and has shown that fundamental behavior differences in race groups can be explained on a cultural basis. He concludes "that there is no adequate proof of fundamental race differences in mentality, and that those differences which are found are in all probability due to culture and the social environment." The book contains exhaustive material with clear and lucid exposition of facts intended primarily for students and the intelligent layman. Every student interested in ethnology should have a copy of this book.—R. E. G.

The Technique of Contraception; an Outline. By E. M. Mastner. Published for the National Medical Council on Birth Control, by the Williams & Wilkins Co., Baltimore, 1936. 40 pp., illus. Price, $0.50.

This is a short, concise, and to-the-point manual of practical instruction on the safest and most effective methods of contraception known at present.

In a foreword by Robert L. Dickson, the point is brought out, one that is too often overlooked, that from a standpoint of safeguarding the health of mothers, the whole question of contraception is of public-health significance and properly belongs to the department of preventive medicine.

In the discussion of the technic of contraception the author makes the usual divisions into general measures applicable to the male, measures used by the female, and measures giving prolonged protection such as intra-uterine stems, hormones, spermotoxins.

Though it is written primarily for the medical profession, there is nothing in the outline that would not be readily understood by an intelligent layman.

Despite its brevity, the book is profusedly illustrated by diagrams, showing the precise manner in which vaginal diaphragms and cervical caps should be used. The book is very practical and worth reading by any student interested in the subject.—U. D. M.